FINANCIAL LIBERALISATION, PRIVATISATION AND PRODUCTIVITY IN BANKING:
THE EXPERIENCE OF TWO EMERGING ECONOMIES

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Abstract

Banking systems in emerging and developing economies hold the key to
economic growth and productivity change at the macroeconomic level. As
financial globalization proceeds, many emerging economies are reforming their
banking systems through the process of liberalisation, privatisation and
deregulation, especially where state-owned banks have previously been dominant.
This thesis uses both parametric and non-parametric methods, namely and
Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA)
respectively, to measure the efficiency and productivity growth in the banking
systems of two emerging economies – Turkey and Egypt. Coelli, Perelman and
Romano (1999) approach is used for the banking sector for the first time in the
literature. The pervasive gap is also addressed in the literature by empirically
comparing the DEA and SFA efficiency scores following Bauer et al. (1998)
conditions. A generalised parametric Malmquist approach is specified using the
distance functions for both data sets.

The findings show that Turkey and Egypt have various similarities. Both have
undergone significant regulatory, ownership and market structure changes in the
last two decades. The reform policies in both countries are stimulated by the IMF
and World Bank. Egypt, as an emerging economy, has introduced a wide range of
structural economic reforms to create a viable banking system in the past decade
by adopting a cautious approach in liberalisation implementation. However,
Turkey’s approach was expeditious. Both banking sectors efficiency and
productivity improved as response to the liberalisation policies. However,
Turkey’s experience of financial crisis overwhelmed the obtained efficiency. The
results on the separate economies suggest that scale effects can be important in
identifying the initial impact of financial liberalisation policies on the
productivity of banking sector.

Mohamed Shaban M. Hassan
This thesis is dedicated to my family,
Acknowledgment

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Table of Contents

Abstract.......................................................................................................................... II
Acknowledgment........................................................................................................ IV
Abbreviations ................................................................................................................ XIV

1 Chapter one: Introduction......................................................................................... 1
  1.1.   Motivation........................................................................................................... 1
  1.2.   Objectives and Contribution........................................................................... 5
  1.3.   The Choice of Methodology............................................................................. 7
  1.4.   Thesis Organisation........................................................................................ 9

2. Chapter two: Literature Review............................................................................. 12
  2.1.   Introduction...................................................................................................... 12
  2.2.   Empirical literature.......................................................................................... 16
  2.2.1.  Efficiency and Productivity Studies on Turkish banks......................... 16
  2.2.2.  Efficiency and Productivity Studies in the Middle East and North Africa (MENA) .................................................................................................................. 28
  2.2.3.  Efficiency and Productivity Studies in other Emerging Economies Banking .................................................................................................................. 32
  2.2.3.1. South East Asia (SEA): ................................................................................ 32
  2.2.3.2. East Asia (EA) The Indian continent: ...................................................... 41
  2.2.3.3. Emerging Economies in Europe: ............................................................... 48
  2.3.   Conclusion ....................................................................................................... 54

3. Chapter three: Egypt and Turkish banking sectors............................................. 58
  3.1.   Introduction....................................................................................................... 58
  3.2.   Industry Analysis Egyptian Banking Sector............................................... 60
  3.2.1.  Historical background:.................................................................................. 60
  3.2.2.  Nationalisation and Financial Repression.................................................... 61
  3.2.3.  Pre-Liberalisation (Liberalisation attempt “Open door policy”) .. 65
  3.2.4.  Financial Liberalisation 1991 ....................................................................... 67
  3.3.   Industry Analysis - Turkish Banking Sector................................................. 72
  3.3.1.  Historical Background: ................................................................................ 72
  3.3.2.  Financial Repression 1960 – 1979 ............................................................... 73
  3.3.3.  Financial Liberalisation 1980 - 1994............................................................. 75
  3.3.4.  The 1994 crisis............................................................................................. 78
3.3.5. The Period between 1999 and 2001 (Period of two Crises) ........ 80
3.3.6. After the 2001 Crisis ................................................................. 81
3.4. A comparison of Egypt and Turkey ........................................... 82
3.5. Conclusion ..................................................................................... 85
4. Chapter four: Methodology .............................................................. 87
4.1. Introduction .................................................................................... 87
4.2. Farrell’s Efficiency Measures ......................................................... 89
4.3. Why Frontier Methods? ............................................................... 93
4.4. Why Two Methods? ..................................................................... 95
4.5. Non-parametric Methods: Data Envelopment Analysis (DEA)..... 98
4.5.1. Technical Efficiency (DEA) ......................................................... 98
4.5.2. The CCR Model ....................................................................... 100
4.5.2.1. Primal ...................................................................................... 102
4.5.2.2. Dual ........................................................................................ 102
4.5.3. Nonparametric Productivity Measurement: DEA-based Malmquist Productivity Index ................................................................................. 106
4.5.4. Model specification for the Non-parametric Methods .......... 111
4.5.4.1. Efficiency Model ..................................................................... 111
4.5.4.2. Productivity Model ................................................................. 112
4.6. Parametric Methods: Stochastic Frontier Analysis (SFA) ........ 114
4.6.1. Stochastic Frontier Models for Panel Data. ............................... 116
4.6.2. Distance Functions and Stochastic Frontier Analysis .......... 123
4.6.3. The Generalised Parametric Total Factor Productivity Index (GMTFPI) ..................................................................................... 127
4.6.4. Parametric Models Specification .............................................. 136
4.6.4.1. Time variant and Time invariant Models.......................... 137
4.6.4.2. Environmental effects model ............................................ 138
4.6.4.3. Hypothesis Test ................................................................. 141
4.6.4.4. Model’s restriction hypothesis ............................................ 141
4.7. Data and Variables ........................................................................ 142
4.7.1. The Variables Specification and Definition ......................... 143
4.7.1.1. The Inputs and Outputs Specification .............................. 143
4.7.1.2. Inputs and Outputs Definition .......................................... 144
4.7.1.3. Environmental and Bank specific variable variables ..... 146
6.4.4. The Parametric Productivity of the Turkish Banks .....................260
  6.4.4.1. Ownership, Size, and Bank’s Productivity ............................264
  6.4.4.2. Crisis implication on productivity growth .............................266
6.5. Conclusion ..................................................................................269

7. Chapter seven: Comparison between Non-parametric and Parametric
Results ..................................................................................................271
7.1. Introduction .................................................................................271
7.2. Previous studies ..........................................................................272
7.3. Methodology .............................................................................277
7.4. Statistic tools .............................................................................279
  7.4.1. Spearman’s Rank Correlation Coefficient: .........................279
  7.4.2. Kendall’s Rank Correlation Coefficients: ...............................279
7.5. Data: .............................................................................................282
7.6. Empirical results ..........................................................................283
  7.6.1. Condition one: Comparability of means and standard deviation.283
  7.6.2. Condition two: Ranking Similarity ........................................284
    7.6.2.1. Cross-section Ranking Similarity (Egypt) .......................285
    7.6.2.2. Cross-section Ranking Similarity (Turkey) ......................287
  7.6.3. Condition three: Same identification of best and worst practice banks
     ..............................................................................................................288
  7.6.4. Condition four: stability over time .......................................290
  7.6.5. Condition five: consistency with competitive conditions ........292
7.7. Extension to Bauer et al. (1998) consistency conditions ............299
  7.7.1. Proposed condition seven (consistency with ranking bank groups)
    “Does heterogeneity matters?” ......................................................301
  7.7.2. Proposed condition eight (consistency in ranking banks within sub-
    periods) “Is counting for economic environment changes matters?” ......304
    7.7.2.1. The hypothesis to be tested here: ...................................305
7.8. Conclusion ..................................................................................307

8. Chapter eight: Conclusion ............................................................310
8.1. Empirical Findings .....................................................................311
8.2. Policy implications .....................................................................315
8.3. Limitations .................................................................................318
8.4. Future Research ........................................................................319
APPENDICES: .................................................................347

Appendix 1: Table 1 Structure of the Egyptian Banking System (Part A)347
Appendix 1: Table 1 Structure of the Egyptian Banking System (Part B)348
Appendix 1: Table 2: Egyptian Banks Aggregate Balance Sheet........349
Balances with banks abroad .................................................................349
Appendix 1: Table 3: Egyptian Sample Banks Yearly Growth of Total Loans,
Total Deposits and Total Assets by Ownership Category (1991-2002) ..350
Appendix 1: Table 4: Egyptian Sample Banks Market share of Total Loans,
Total Deposits and Total Assets by Ownership Category (1991-2002) ..351
Appendix 1: Table 5: Joint Venture (JV) Banks Privatisation offers in Egypt
(1996-1999) ..................................................................................352
Appendix 2: Table1. Turkish Banking Sector: Selected Indicators for the
Selected Years from 1980 to 2000 .......................................................353
Appendix 2: Table 3 The Situation of the Banks Under SDIF from 1997 to
January 25, 2002 .............................................................................354
Appendix 3: Table 1. Comparison between Egypt and Turkey ............355
Appendix 4: The Malmquist Productivity index Decomposition Dilemma356
Appendix 5: The Origin and Development of the Stochastic Frontier Analysis
(SFA): ................................................................. 360
Malmquist Total Factor Productivity Index and its components: ........364
Appendix 7: STATA 9.1. Code for the Turkish banks data Generalised
Malmquist Total Factor Productivity Index and its components ........365
Appendix 8: Table 1 Non-parametric Yearly Average Technical efficiency
scores and Returns to Scale Egyptian banks.................................366
Appendix 8: Table 2 Egyptian Banks Non-parametric Average efficiency
scores and Ranks (by Bank) .............................................................367
Appendix 8: Table 2 Egyptian Banks Yearly Non-parametric Average VRS
efficiency scores (by ownership) .................................................368
Appendix 8: Table 3 Egyptian Banks Yearly Non-parametric Malmquist Total Factor Productivity Index (MTFPI) and its components. .......................369
Appendix 9: Table 1 Egyptian Banks Yearly Parametric Average Efficiency (by Ownership)..................................................................................370
Appendix 9: Table 2 Egyptian Banks Yearly Parametric Generalised Malmquist Total Factor Productivity Index (GMTFPI) and its components. .............371
Appendix 10: Table 1 Turkish Market Analysis.........................................372
Appendix 11: Table 1 Non-parametric Yearly Average Technical efficiency scores and Returns to Scale Turkish banks ...............................373
Appendix 12: Table 1 Kendall Correlation Rank for the DEA Efficiency Scores (Egyptian Banks).................................................................374
Appendix 12: Table 2 Kendall Correlation Rank for the SFA Efficiency Scores (Egyptian Banks).................................................................375
Appendix 12: Table 3 Kendall Correlation Rank for the DEA Efficiency Scores (Turkish Banks).................................................................376
Appendix 12: Table 4 Kendall Correlation Rank for the SFA Efficiency Scores (Turkish Banks).................................................................377

List of tables
Table 4- 1 Comparison between SFA and DEA........................................... 97
Table 4- 2 the outputs and inputs in USDS Millions ..................................145
Table: 5-2- 1 Summary of market share and growth: Total loans, deposits and assets by ownership .................................................................152
Table: 5-2- 2 Descriptive statistics.............................................................154
Table:5-3- 1 Average efficiency by period.................................................156
Table: 5-3- 2 Average Efficiency (VRS) by Ownership and Size categories over sub-periods .................................................................160
Table: 5-3- 3 Mean MTFPI by period ........................................................168
Table:5-3- 4 MTFPI and its components by ownership over sub-periods171
Table:5-3- 5 MTFPI by Size .......................................................................173
Table: 5-4- 1 The Estimated Efficiency Models ..........................................178
Table: 5-4- 2 Models-specific Assumptions Hypothesis test......................181
Table: 5-4- 3 Models’ specification test.......................................................183
Table: 5-4- 4 the Descriptive statistics for the estimated efficiency ............186
Table: 7-4-1 SFA and DEA efficiency rank by bank (Egypt) ............286
Table: 7-4-2 SFA and DEA efficiency rank by bank (Turkey) ............287
Table: 7-4-3 SFA and DEA Efficiency and Ranking by percentile ........289
Table: 7-4-4 SFA and DEA Rank correlation best and worst practice .290
Table: 7-4-5 Spearman Rank Correlation SFA Ranks and DEA Ranks [Egypt] .................................................................................................................................294
Table: 7-4-6 Spearman Rank Correlation SFA Ranks and DEA Ranks [Turkey] .................................................................................................................................295
Table: 7-4-7 Comparison between SFA and DEA scores during sub-periods [Egypt] .................................................................................................................................297
Table: 7-4-8 Comparison between SFA and DEA scores during sub-periods [Turkey] .................................................................................................................................298
Table 7-5-1 Spearman’s Kendall’s coefficients SFA and DEA comparison by ownership and size ..................................................................................................................301
Table 7-5-2 Sub-periods comparison Spearman’s Rank and Kendall’s Rank correlation coefficients [Egypt and Turkey] ..................................................................................................................304
List of Figures

Figure: 4.1 Farrell’s Input Efficiency Measures .......................................................... 90
Figure: 5-3- 1 VRS technical efficiency, CRS technical efficiency and Scale
efficiency .................................................................................................................. 157
Figure: 5-3- 2 the technical efficiency by ownership over years .......... 163
Figure: 5-3- 3 the Malmquist Total Factor Productivity Index and its
components ............................................................................................................. 167
Figure 5-4- 1 Technical Efficiency Scores Correlation Matrix .......... 186
Figure 5-4- 2 Kernel Density for the estimated models of Technical Efficiency
................................................................................................................................. 188
Figure 5-4- 3 Kernel density distribution for the Egyptian banks’ technical
efficiency .................................................................................................................. 192
Figure 5-4- 4 Average efficiency by ownership over the sample period . 194
Figure 5-4- 5 technical efficiency by size ......................................................... 196
Figure 5-4- 6 Productivity Change and its components based on M4 estimation
................................................................................................................................. 119
Figure 5-4- 7 GMTFPI and its components by bank group ................. 205
Figure: 6-2- 1 Intermediation ratio for the industry, sample and ownership
groups ..................................................................................................................... 213
Figure: 6-3- 1 Turkish banks average CRS, VRS and scale efficiency ... 220
Figure: 6-3- 2 Technical Efficiency by Ownership group ....................... 221
Figure: 6-3- 3 The Malmquist productivity index and its components ... 227
Figure: 6-3- 4 Malmquist index and its components by bank group ..... 229
Figure: 6-4- 1 Kernel density for the estimated technical efficiency ...... 250
Figure: 6-4- 2 Technical Efficiency (M4a) ......................................................... 255
Figure: 6-4- 3 Technical efficiency by ownership category ................. 257
Figure: 6-4- 4 Turkish banks technical efficiency by size during sub-periods.
................................................................................................................................. 259
Figure: 6-4- 5 Generalised Malmquist productivity index Turkish banks ..
................................................................................................................................. 262
<table>
<thead>
<tr>
<th>Abbreviations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCC</td>
<td>Banker, Charnes and Cooper</td>
</tr>
<tr>
<td>BRSA</td>
<td>Board of Bank Regulation and Supervision</td>
</tr>
<tr>
<td>CBE</td>
<td>Central Bank of Egypt</td>
</tr>
<tr>
<td>CBT</td>
<td>Central Bank of Turkey</td>
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<tr>
<td>CCD</td>
<td>Caves, Christensen and Diewert</td>
</tr>
<tr>
<td>CCR</td>
<td>Charnes, Cooper and Rhodes</td>
</tr>
<tr>
<td>CCV</td>
<td>Change in Coefficient of Variation</td>
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<tr>
<td>CEE</td>
<td>Central and Eastern Europe</td>
</tr>
<tr>
<td>CRS</td>
<td>Constant Returns to Scale</td>
</tr>
<tr>
<td>CV</td>
<td>Coefficient of Variation</td>
</tr>
<tr>
<td>DEA</td>
<td>Data Envelopment Analysis</td>
</tr>
<tr>
<td>DFA</td>
<td>Distribution Free Approach</td>
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<tr>
<td>DMU</td>
<td>Decision Making Unit</td>
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<tr>
<td>EC</td>
<td>Efficiency Change</td>
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<tr>
<td>ERSAP</td>
<td>Economic Reform and Restructuring Adjustment Programme</td>
</tr>
<tr>
<td>FDH</td>
<td>Free Distribution Hull</td>
</tr>
<tr>
<td>FGLR</td>
<td>Färe, Grosskopf, Lindgren and Roos</td>
</tr>
<tr>
<td>FGNZ</td>
<td>Färe Grosskopf, Norris and Zhang</td>
</tr>
<tr>
<td>GCC</td>
<td>Gulf Cooperation Council</td>
</tr>
<tr>
<td>GMTFPI</td>
<td>Generalised Malmquist Total Factor Productivity Index</td>
</tr>
<tr>
<td>IMF</td>
<td>International Monetary Fund</td>
</tr>
<tr>
<td>JLMS</td>
<td>Jondrow, Lovell, Moresten and Schmidt</td>
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<tr>
<td>JV</td>
<td>Joint Venture Banks</td>
</tr>
<tr>
<td>JV_TF</td>
<td>Joint Venture Banks sold to Foreign Ownership</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>JV_TP</td>
<td>Joint Venture Banks sold to Private Ownership</td>
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<tr>
<td>LP</td>
<td>Linear Programming</td>
</tr>
<tr>
<td>LR</td>
<td>Likelihood Ratio</td>
</tr>
<tr>
<td>MENA</td>
<td>Middle East and North Africa</td>
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<tr>
<td>MTFPI</td>
<td>Malmquist Total Factor Productivity Index</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>OLS</td>
<td>Ordinary Least Square</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>Private Banks transformed to the SDIF</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>Privatised State-owned Banks later transformed to SDIF</td>
</tr>
<tr>
<td>SAP</td>
<td>Structural Adjustment Programme</td>
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<tr>
<td>SD</td>
<td>Standard Deviation</td>
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<tr>
<td>SDIF</td>
<td>Saving and Deposits Insurance Fund</td>
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<tr>
<td>SEC</td>
<td>Scale Efficiency Change</td>
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<tr>
<td>SFA</td>
<td>Stochastic Frontier Analysis</td>
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<tr>
<td>SFH</td>
<td>Special Finance Houses</td>
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<tr>
<td>TBB</td>
<td>Turkish Banking Association</td>
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<tr>
<td>TC</td>
<td>Technological Change</td>
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<tr>
<td>TFP</td>
<td>Total Factor Productivity</td>
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<td>TL</td>
<td>Turkish Lira</td>
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<td>VRS</td>
<td>Variable Returns to Scale</td>
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<td>WB</td>
<td>World Bank</td>
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1 Chapter one: Introduction

This chapter describes the background of the study consisting of motivation, objectives, contributions and the methodology chosen. The last section provides a brief summary of the thesis highlighting the contents of each chapter.

1.1 Motivation

The wave of financial markets liberalisation that emerged in the early 1960s was not only confined to the advanced developed countries, i.e. UK, Japan, France, and Australia. It spread in subsequent years to other countries i.e. emerging economies of developing countries (Gibson and Tsakalotos, 1994). For example, over the last two decades emerging economies have widely implemented financial liberalisation programmes, which were prescribed by the International Monetary Fund (IMF) and World Bank (WB) as part of economic adjustment plans to reshape their economies. These programmes mainly aimed to eliminate the state control and intervention in the financial systems and enhance competition, improve resource allocation and thus, efficiency in the financial institutions (Beim and Calomiris, 2000). It is important to find out whether the financial liberalisation programmes have indeed been successful in achieving these results in emerging economies - this is the main motive of this thesis.

Prior to economic and financial reforms, most of the emerging economies suffered from financial repression policies, which interfered with the price mechanism and competition, and thus affected the effectiveness of the intermediation process
between financial institutions and savers or investors (McKinnon, 1973; Shaw, 1973). In most of these economies, financial intermediation activities are primarily undertaken by banks. Other financial institutions (i.e. insurance companies, investment banks, alternative and finance houses etc.) seem to have a diminished role in the financial system due to relatively slow or inactive capital markets (Beim and Calomiris, 2000). Hence the banking sector played a vital and perhaps almost the only intermediation role. Many banks in emerging economies were owned by the state and governments were directly involved in determining the interest rates on deposits and loans; regulating the new entries of domestic and foreign banks; and controlling the establishment of new banks branches. It is widely believed that for developing economies, the banking sector development is significant since a bank-based system has a greater impact on growth at the early stage than does a market-oriented financial system (Fase and Abma, 2003; Tadesse, 2002).

In any highly regulated environment, it is a commonly held view that banks were not encouraged to enhance their performance either through the reduction of operating costs or improving the efficient allocation of loans and deposits. The founders of ‘financial liberalisation’ thesis, McKinnon (1973) and Shaw (1973) argue that restrictions by governments on the banking system operations restrain the quantity and quality of investment. Therefore from the late 1980s, governments introduced financial liberalisation reforms which aim to enhance efficiency and productivity of the banking system.

Such reforms were conducted with a greater emphasis placed on monitoring banks’ risk management instead of individual transactions, removing interest rate ceilings
and mandatory credit allocations, and reducing restrictions on the entry, encouraging foreign banks and opening of branches and privatising the state-owned banks (Zaim, 1995). In theory financial liberalisation is expected to advance the financial intermediation and thus improve bank efficiency (Berger and Humphrey, 1997). Nevertheless empirical studies investigating the relationship between financial liberalisation reforms and efficiency of banks provide mixed results (See Chapter 2 for a comprehensive review of the empirical research which focuses on a number of emerging economies).

Measuring bank performance can be achieved by employing either quantitative or qualitative analysis. In the case of banks’ performance, quantitative analysis using secondary data tends to be easier choice given the complication and difficulties facing researchers in compiling qualitative information on banks’ operations due to the sensitive nature of banking operations. Quantitative analysis can broadly distinguish between two approaches: the non-frontier or the traditional approach and the frontier approach. The former approach employs ordinary least square (OLS) techniques to investigate banks performance using financial ratios.

The frontier approach which gained wide popularity since Farrell’s (1957) seminal work, measures banks performance relative to a best practice frontier. Two prominent methodologies can be adopted to perform frontier analysis, namely the mathematical non-parametric method and the econometric parametric method. The frontier approaches are superior for regulatory purpose compared to non-frontier methods - financial ratios. Hence, they use programming or
econometric techniques to eradicate the effects of exogenous market factors on inputs and inputs prices (Berger and Humphrey, 1997).

This thesis concentrates on two emerging economies, specifically aiming to investigate the effects of financial liberalization policies on the efficiency of the Egyptian and Turkish banking industries. Lack of comparative studies to examine the effects of financial liberalization policies on the efficiency of emerging economies’ banking industries motivated this thesis. The main interest is on those countries which experienced similar financial liberalisation programmes but achieved differing post-liberalisation outcomes. It is worthwhile to investigate the role of these programmes on the performance of banking sectors in both Egypt and Turkey.

Why this particular interest on Egypt and Turkey? Interestingly, these two emerging economies, Egypt and Turkey implemented similar financial liberalisation policies and thus, experienced different outcomes. For example, Egypt’s financial system remained relatively stable over the study period largely due to its cautious and well-timed deregulation process. However, Turkey, similar to some other emerging economies, having liberalised their banking systems rapidly faced financial crises in the form of increased banking sector fragility which stemmed from increased opportunities for excessive risk-taking by relatively weak institutions (Demirguc-Kunt and Detragiache, 1997).

Detailed attention in this thesis is paid to whether or not reforms have unevenly affected banks in each economy over time, and how different ownership structures may be implicated in the difference. Data on individual banks from
1991 to 2000 is used for the Turkish case and data on individual banks from 1984 to 2002 is used for the Egyptian case. The next section details the objectives and contributions of the thesis.

### 1.2. Objectives and Contribution

The main objective of this study is to investigate the performance of two emerging economies banking sector during periods of economic changes - the impact of liberalisation policies on the Egyptian banks efficiency and productivity, and the impact of post-liberalisation financial disruption on the Turkish banks’ performance. This thesis aims to reveal whether periods of changes in economic policies represented in financial liberalisation and financial crisis would affect various forms of banks’ ownership and size with different magnitude. Further, the thesis investigates whether the environmental variables and banks specific characteristics determines the variability in technical inefficiency or the shape of production technology. Finally the thesis provides empirical analysis by comparing empirical results obtained between the Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) efficiency scores.

**In summary, the research questions are:**

1. Do liberalisation policies and financial crisis affect banks efficiency and productivity?
   1a. Do liberalisation policies improve the Egyptian banks efficiency and productivity?
   1b. Do financial crisis offset the efficiency gains obtained by the Turkish banks
during the initial years of liberalisation?

1c. Do liberalisation policies create winners and loser among different bank forms of ownership and size?

1d. Do liberalisation policies have short-term impact on banks’ performance?

2. Do environmental and bank-specific variables affect inefficiency or the shape of the production technology?

3. Do the DEA and SFA methods provide consistent efficiency results?

The present thesis contributes to the literature with three unprecedented dimensions:

This is the first empirical study which measures the efficiency and productivity with sole focus on the Egyptian banks during pre- and post-liberalisation periods.

This thesis is the first banking study to conduct empirical test to validate whether environmental and bank-specific variables affect the variability in average inefficiency (Battese and Coelli, 1995) or the shape of the production technology (Good et al. 1993) and (Coelli, Perelman and Romano, 1999).

This thesis is the first to introduce the flexible Kendall Rank Correlation compared to the Spearman’s Rank correlation as a comparison tool between the SFA and DEA efficiency ranks.
1.3. The Choice of Methodology

This thesis aims to measure the efficiency and productivity of two emerging countries banking system. There are two prominent methods in this vein which can be employed namely, the SFA, and DEA. Both methods provide measures of technical efficiency as a radial distance from the best practice frontier. However, each method obtains the technical efficiency scores by utilising different techniques. The parametric econometric technique for the SFA method counts for data noise and allows for hypothesis testing however, it requires prior assumption of the shape of the production technology (i.e. production, cost, and profit function, etc.) and the inefficiency term (normal, half normal, and exponential, etc.)

The DEA is a non-parametric linear programming which does not require a prior behavioural assumption or distribution assumption for the inefficiency terms. DEA does not allow for statistical methods, and its deterministic nature means does not count for data noise or outliers. There is no consensus in the literature so far on which method is preferred to detect the best-practice frontier (Berger and Humphrey, 1997).

Both DEA and SFA methods can be used to estimate productivity measure namely the non-parametric DEA-based Malmquist Total Factor Productivity Index (MTFPI) (Fare, Grosskopf, Norris, and Zhang, 1994) and the SFA based parametric Generalised Malmquist Total Factor Productivity Index (GMFPI) (Orea, 2002). Under both methods, both indexes can be decomposed into three
components of productivity growth, namely Technical Efficiency Change (EC), Technological Change (TC) and Scale Efficiency Change (SEC).

The frontier methods are considered superior in measuring firm’s and managerial performance compared to the non-frontier methods (i.e. financial ratios) in particular for regulatory purposes. The frontier methods are widely used in analysing the impact of regulatory policies (liberalisation, deregulation, privatisation and financial disruption), merger acquisition, and foreign ownership entrance on the performance of the firms (Bauer et al., 1997) and (Berger and Humphrey 1997). The use of different approaches to investigate the economic phenomenon is an appraisable procedure to crosscheck the robustness of the results obtained from alternative methods, in particular, when firms operate in diverse and extreme conditions (i.e. regulatory changes) (Charnes, Cooper, and Sueyoshi, 1998). There are few banking studies which simultaneously applied the two methods [among others, see Resti (1997); Bauer et al. (1998); Casu et al. (2004) and Becalli et al. (2006)].

Consequently, this thesis applies both parametric and non-parametric methods to exploit the advantages of each method and to ensure the robustness of the results. Moreover, this thesis aims to provide an empirical comparison between the results obtained from each method following Bauer et al. (1998) consistency conditions.
1.4. Thesis Organisation

This thesis aims at bridging the gap in the literature by empirically investigating the efficiency aspects of the commercial banks in Egypt and Turkey. This thesis is organised into eight chapters. Chapter two reviews previous studies, chapter three provides detailed information on the banking industry in Egypt and Turkey, and chapter four introduces the methodologies used to obtain the empirical results. The analyses of the empirical results are presented in chapters five, six and seven. Each of these empirical chapters is independent in the sense that each empirical chapter has its own data, methodology and results. Finally chapter eight concludes the empirical findings of the thesis. The chapters’ contents are briefly explained below:

The second chapter presents a comprehensive survey on the impact of liberalisation and deregulation on banking sectors performance in emerging economies. The chapter focuses on the studies which used frontier methods to measure either the efficiency or the productivity of banking sectors during periods characterised with changes in economic policies. The chapter attempts to encompass various experiences from different regions world wide. The most prevailing conclusion from the survey is that liberalisation tends to provide rather fruitful outcome within banking systems which apply prudent regulations and governance. Moreover, financial disruption and economic instability tend to deter pre-gained liberalisation benefits.

Chapter three provides knowledge on the evolution and nature of the banking
sectors in the two countries, Egypt and Turkey. The two countries have common political and economic history and the banking sectors in both countries were financially repressed before the implementation of liberalisation. Turkey seems to have expediting manner in implementing liberalisation policies which led to financial disruption in the subsequent years. In contrast, Egypt gradually applied the liberalisation policies and did not experience any financial crisis.

Chapter four starts with a brief summary on the evolution of both the parametric and non-parametric frontier methods. The chapter follows in details the applied non-parametric method DEA to measure the efficiency and the computation of the non-parametric DEA base Malmquist productivity index. The subsequent section introduces the parametric SFA method. The Generalised Malmquist Total Factor Productivity index is summarised at the end of the chapter.

Chapter five analyses the impact of financial liberalisation on the Egyptian banks. The chapter is composed of two major sections. The first section is concerned with the discussion of the empirical results obtained from the non-parametric estimation of efficiency and productivity. The second section analyses the parametric efficiency and productivity estimation empirical results. The chapter concludes that liberalisation improves the Egyptian banks’ efficiency. However, further efforts in this vein are required to reduce the efficiency gap between the state-owned banks and other ownership strata.

Chapter six discusses the effect of financial crisis on the efficiency and productivity of the Turkish banks. Two methodologies are applied to obtain the
efficiency and productivity measures of the Turkish banks. Similar to previous studies, the empirical findings suggest that Turkish banks suffer from efficiency regress during financial disruption years. The financial crisis offsets the pre-obtained efficiency gains post-liberalisation.

Chapter seven provides empirical analysis by comparing between the SFA and DEA estimated efficiency from the preceding empirical chapters six and seven. The chapter follows Bauer et al. (1998) consistency conditions and introduces two more conditions. The chapter finds that only few banking studies use two methodologies and all of them use Spearman’s Rank Correlation. The chapter also introduces Kendall’s Rank Correlation to the literature and concludes that in most of the conditions, the SFA and DEA tend to provide inconsistent ranks.

The thesis concludes with final remarks in chapter eight. The chapter starts with summary of the empirical findings followed by policy implications on liberalisation and banks’ performance in emerging economies. Finally, the chapter summarises the limitations of the thesis and suggests new avenues for future research.
2. Chapter two: Literature Review

2.1. Introduction

The aim of financial liberalisation is to transform the financially repressed markets into liberal financial markets in order to promote competition and efficiency among the financial institutions. These liberal policies encompass *inter alia* freeing the interest rate, reduce government control on directing credit, reducing reserve requirements, abolish barriers to entry and privatising state-owned banks (Beim and Calomiris, 2000).

McKinnon (1973) and Shaw (1973) emphasise on two effects of financial repression. First, financial repression affects the efficiency of allocating savings to investments; and second, it affects the return on savings. Consequently, it influences the equilibrium levels of savings and investments. MacKinnon clarified that financial repression can lead to dualism in which firms that have access to subsidised funds will aim to invest in relatively capital-intensive technologies. In contrast, firms that deprived from such privilege will choose high-yield and short-maturity projects. In contrast within liberal financial market, the market forces determine the credit allocation. Savings and investment are assumed to be balanced (i.e. real interest rates are adjusted to its equilibrium). This leads to improvement in the overall efficiency of investment, improves average productivity of capital and the low yielding investment would be eliminated (Arestis, 2005).
The International Monetary Fund (IMF) and World Bank (WB) prescribed financial liberalisation policies to developing countries as part of more general liberalisation or stabilisation reform programmes as a prerequisite condition for free markets. However, the subsequent events, i.e. post-liberalisation financial crisis which occur in many of these countries critically questioned the prescribed models by the IMF and WB (Arestis, 2005).

McKinnon (1989) elaborates that stabilising real interest rate prices in liberalised financial environment is far from easy and full of potential pitfalls. Nevertheless, financial and trade liberalisation remain “the only game in town” as far as successful economic development is concerned. Gibson and Tsakalotos (1994) criticise McKinnon’s view and argue that it is misleading to characterise all forms of government interventions in financial markets as “financial repression”. The authors suggest hybrid strategies built on better understanding of developing countries financial markets. These strategies combine measures of financial liberalisation with the development of old or the creation of new financial institutions. McKinnon (1991) argues that liberalisation fails because of implicit or explicit deposit insurance associated with inadequate and macroeconomic stability. The fashion of which these liberalisation policies are implemented has also significant impact on the success of these policies. A gradual implementation of liberalisation polices is favoured and applauded compared to precipitated implementation which is likely leads to financial disruption (Caprio and Cull, 2000) and (McKinnon, 1991).
The banking sectors in emerging economies play vital role towards the economic development of these countries. Hence, often in these countries compared to other financial institutions the banking sector endures the majority of financial intermediation activities in the economy (Beim and Calomiris, 2000). One of the principal objectives of implementing financial liberalisation programmes is to improve the efficiency of the banking industry. Consequently, measuring the impact of financial liberalisation policies on the banking sector performance is of a fundamental importance to assist policy makers in reconsidering and or pursuing their adopted policies (Berger and Humphrey, 1997).

Berger & Humphrey (1997) present an excellent survey of 130 studies that use frontier analysis for financial institutions in 21 countries. It is evident from this survey that there are relatively fewer studies on emerging economies’ financial institutions compared to the vast amount of literature on developed countries’ financial institutions. Thus, the authors urge further research to be done in this vein to fill the gap in the literature. Moreover, they highlight the importance of cross-country comparison studies to investigate the impact of regulatory policies on financial institutions’ efficiency.

The deregulation of financial institutions can either deteriorate or improve the efficiency of the banking sector. Hence, some countries experience a decline in average efficiency after deregulation represented in excessive expansion in branching and rapid asset growth. On the other hand, deregulation contributes to a favourable efficiency and productivity growth in other countries (Berger et al. 1993 and Berger et al. 1997). In the last decade, it has been evident that the
empirical studies which examine the significance of deregulation and liberalisation reforms on emerging economies’ financial institutions have progressively increased.

The present chapter aims to review this empirical literature on previous studies which investigate banks’ efficiency and productivity in emerging economies particularly during periods of financial reforms. Different countries’ experiences of financial liberalisation and deregulation are elaborated in these studies to understand the impact of liberalisation and regulation on the performance of the banking sector. The chapter also considers the effect of financial disruption on the banking sectors in general and also on different forms of ownership. It is also of the interest in this chapter to understand whether the privatisation of state-owned banks or the foreign ownership acquisition would lead to an improvement on the bank performance.

This chapter is organised as follows. The first section reviews the previous literature of the impact of liberalisation on the efficiency and productivity of Turkish banks. The second section reviews studies from the Middle East and North Africa (MENA). The third section reviews the liberalisation experience and the impact on banks’ performance on other emerging economies. The final section is the conclusion.
2.2. Empirical literature

2.2.1. Efficiency and Productivity Studies on Turkish banks

This section will review efficiency and productivity studies on Turkish banks. Examining Turkish banks performance attracted great academic interest since the first academic paper on Turkish bank performance measurement was published by Zaim (1995). This study investigates the impact of liberalisation policies on the performance of Turkish commercial banks. In particular, it compares the efficiency of Turkish banks in two periods, namely 1981 and 1990, to mark the significance of the pre liberalisation reforms in 1980 with respect to the efficiency scores in 1991 to mark the importance of liberalisation reforms.

The study uses the intermediation approach of Sealy and Lindley (1977) to calculate both production and cost function frontiers to examine and report the scale effect, technological change and cost reduction on the Turkish banks between the two periods. Zaim (1995) employs linear programming DEA technique using four outputs and for inputs besides controlling environmental variables. The outputs used are demand and time deposits, and short and long term loans while the inputs are the number of employees, interest expenditure, depreciation expenditure and expenditure on materials.

Zaim (1995) finds that Turkish banks experience significant scale growth in 1991 compared to the year, 1981 representing the evidence that financial reform policies enhance banks’ performance. Improvements of both technical and
allocative efficiency are also evident in the study. The state-owned banks outperform the private banks’ efficiency. A questionable drawback in this study is that data on solely two representative years 1981 and 1990 are used to investigate the effect of liberalisation on the Turkish bank’s performance.

Similar to Zaim (1995), Yildirim (2002) also uses DEA to investigate the impact of macroeconomic circumstances on the efficiency of the Turkish commercial banks during the period 1988-1999. The study adopts the intermediation approach using four inputs (total demand deposits, total time deposits, total interest expenses and total non-interest income) and three outputs (total loans, interest income and non-interest income).

The results show the existence of immense variation in both pure technical and scale efficiency measures with no significant evidence of sustainable efficiency gains. During the whole period the decline in scale efficiency is prominent—the banks suffer from decreasing returns to scale. Yildirim (2002) finds that larger size banks seem to be more technical and scale efficient compared to small banks. Moreover efficient banks are more profitable.

Similar to Zaim (1995) the study finds that state-owned banks outperform both private and foreign banks in terms of technical efficiency however, they are less profitable but better than private banks with respect to scale efficiency. Yildirim (2002) also corresponds with Zaim (1995) in the sense that significant initial efficiency gains are evident in the 1980s. Yildirim (2002) emphasises that the improvement was not sustainable given the unstable macro-economic
environment during the study period. The undesirable effects of the macro-economic environment are rather significantly evident on private banks. Unlike private and state-owned banks, foreign banks seem to be relatively less affected by the unfavourable economic environment. The author argues that the concentration of foreign banks on foreign trade areas rather than traditional banking activities might explain such outcome.

Isik et al (2002) examine the association of different organisational forms (state-owned, private and foreign banks) and Turkish bank performance in the pre- and post-liberalisation periods. By doing so, the study joins the league of limited comprehensive studies in this area, which is done for various countries. [See among others, Grifell-Tatje and Lovell (1997), Bhattacharyya, Lovell and Sahay (1997), Leightner and Lovell (1998), Wheelock and Wilson (1999) and Sathye (2001)]. In this study the productivity development of the Turkish banks is examined over a longer time span, 1981-1990 which covers the pre liberalisation and the initial post-liberalisation periods. Unlike previous studies, this study captures the longer term effects of liberalisation.

The DEA based Malmquist productivity index is used to examine the role of liberalisation policies and thus, explain the productivity and efficiency progress. To select the inputs and outputs variables, two approaches are employed, namely the traditional and non-traditional approaches. The traditional banking approach considers labour, capital and funds as inputs and short/long-term loans and other earning assets. The non-traditional approach includes all the inputs and outputs considered in the traditional approach except this approach incorporates
distinguishing variable which is off-balance sheet items as non-traditional activities.

The results show that all forms of banks experience efficiency and productivity growth in more liberal environment. However, the non-traditional approach model shows higher productivity growth in all organisational forms compared to the results obtained through the traditional approach model. Nonetheless, the magnitude of liberalisation impact varies among the different forms and shows higher impact on foreign banks productivity compared to state-owned and private banks. Moreover, the second half of the period (1982-1986) shows higher levels of efficiency and productivity growth compared to the first period of the study (1987-1990). The authors elaborate that the impact of liberalisation is greater on the banks in the maturity stage.

Another significant result is that overall technological progress is less than expected and has the least contribution to productivity growth in all forms of banks. Particularly, domestic banks seem to have no gains in technology during the liberalisation period despite the heavy investment in computerisation. Moreover, the progress in productivity stems from efficiency and scale growth in state-owned banks and is attributed to long-term loans. The efficiency and scale growth in private banks are more correlated with short-term loans. In contrast technological progress is the major source of productivity growth for foreign banks. This implies that unlike domestic banks, foreign banks tend to have better management practices compared to their local peers.
Isik et al (2002) extend their analysis by regressing the Malmquist productivity index and its components as dependent variable against a group of independent dummy variables, which represent ownership in various forms (i.e. private, state-owned and foreign banks). The results indicate a significant positive trend across time. Also, prior to liberalisation state-owned banks seem to outperform both private and foreign banks in terms of productivity growth. However, the post liberalisation period witnessed higher productivity growth for the foreign banks compared to their private and public counterparts. The performance gap between state-owned banks and private banks started to narrow.

Another study by Isik and Hassan (2002) investigates the technical, allocative and scale efficiencies of Turkish banking industry using non-parametric DEA along with parametric approach to estimate the cost and profit efficiencies. The study aims to examine the impact of different ownership categories and organisational structures on the efficiency of the Turkish banking sector during the period 1988-1996. The study employs the intermediation approach and considers non-traditional outputs; i.e. off-balance sheet items and other earning assets including inter-bank funds, investment securities and loans to special sectors. Other outputs are short-term and long-term loans. The inputs are number of employees, book value of premises and fixed assets and deposits and non-deposits fund.

Unlike Zaim (1995), Isik and Hassan (2002) find that the efficiency of Turkish commercial banks deteriorated in the 1990s. Not only the production efficiency declined but also almost 30% of banks’ resources (allocative inefficiency) and about 20% of banks profits are wasted in the production of banking services.
during 1988-1996. It is suggested that the deterioration in efficiency may due to the increases in cost of funding. Private banks record higher efficiency scores compared to those reported in earlier studies like Zaim (1995). The study attributes this finding to the inclusion of new factors (off-balance sheet activities, repo transactions, inter-bank funds, and lending to special sectors), which is disregarded by other studies. Isik and Hassan (2002) is the first study which include these variables in the literature of Turkish bank performance measurement.

The robust analysis in the study using two different methodologies reveals more characteristics of the Turkish banking sector during the period of study. The study extends the analysis by suggesting that most of the observed technical inefficiency is attributed to operating at incorrect scale rather than operating on the efficient frontier which could be interpreted as managerial inefficiency. There is a negative relationship between size and efficiency and small banks tend to be more cost efficient. Foreign banks seem to be more efficient compared to domestic banks. However, private banks are found to be more efficient than the state-owned banks in terms of all types of efficiency. Isik and Hassan (2002) extend their work with cluster analysis and find that banks listed in Istanbul Stock Exchange tend to be more technically efficient compared to privately held banks. In addition the banks operating under holding company structure seem to be more efficient than independent banks.

Isik and Hassan (2003a) add another dimension to the analysis of Turkish banks performance literature with an aim to examine the impact of bank structure and
corporate control and governance on cost efficiency among different types of banks, which have heterogeneous characteristics. Turkish banks data are used from three different points of time, i.e. 36 banks in 1988, 50 banks in 1992 and 53 banks in 1996. The DEA methodology is used to measure technical and allocative efficiency and further technical efficiency is decomposed into two components, namely pure technical efficiency and scale efficiency. Inputs and outputs selection are similar to Isik and Hassan (2002).

Isik and Hassan (2003a) conclude that on average Turkish banks are 72% cost efficient. In other words around 29% of the banking system resources are wasted in the production process. The results suggest that cost inefficiency is attributed to technical inefficiency rather than allocative efficiency. This implies that Turkish banks’ managers are relatively more outstanding in allocating the banks resources. Similar to Isik and Hassan (2002) and Isik et al (2002), in this study efficiency estimates are also regressed on a group of independent variables which represent bank-specific characteristic, i.e. structure, size, ownership and governance, market power and niche, risk variables as well as other bank specific characteristics.

Another study by Isik and Hassan (2003b) investigates the impact of financial disruption\(^1\) on the bank’s productivity by adopting the intermediation approach and using the same input and output mix as Isik and Hassan (2002). Non-parametric Malmquist Productivity Index is employed to measure the total factor

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\(^{1}\) According to Mishkin (1991) financial crisis can be defined as “a disruption to financial markets in which adverse selection and moral hazard problems become much worse, so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities”.
productivity change (TFPCH) in Turkish commercial banks during the period 1988-1999. This index is further decomposed into the following components, i.e. efficiency change (EFCH), technological change (TCH), and scale efficiency change (SECH) to reveal the sources of inefficiency in the industry during the study period.

Isik and Hassan (2003b) find that the Turkish banking sector only recovers from the impact of the early 1990s financial crisis by the year 1996. The results describe deterioration in the overall banks’ efficiency following the financial crisis in 1994. Furthermore, the study finds evidence of diminished financial intermediation during the distress period, which consequently leads to the shrinking of the industry. Accordingly, there is a higher drop in banks’ output compared to a relatively low decline in the inputs thus, the frontier contracts in the short-run and results in decline in the bank productivity.

Regardless of the size effect, most of the banks suffer from the financial shocks of 1994. However, the impact on small banks was overwhelming. The study argues that this might be due to “the too-big-to-fail” syndrome given the fact that most of the failing banks during 1994 crisis are small size banks. Furthermore, during financial crises, the public tend to favour state banks (most are big size banks) as they consider it safer and relatively less risky.

Demir et al (2005) investigate the determinants of technical efficiency in Turkish banks pre- and post-liberalisation using SFA to estimate translog production frontier. The study clusters the data on two periods; namely 1981-1984 and 1991-
1998 representing pre-liberalisation and post-liberalisation periods respectively. The study follows Hauung and Liu (1994), Battese and Coelli (1995), and Battese and Borca (1997) and use technical inefficiency effects (TIE). Intermediation approach is adopted to estimate the output oriented production function. The output variable is total loans and the input variables are labour, deposits, borrowed funds and equity.

Demir et al (2005) find that pre- and post-liberalisation technical efficiency scores are higher in the banks which involve more traditional banking operations i.e. loans. Post-liberalisation private and foreign banks outperform state-owned banks in technical efficiency however pre-liberalisation period shows statistically insignificant improvement in state-owned banks’ performance compared to the private and foreign banks. The results seem to be consistent with the findings in Zaim (1995). Furthermore, the study elaborates that size matters and larger banks tend to be more efficient.

El-Gamal and Inanoglu (2005) investigate efficiency of the Turkish banking system over the eleven year period from 1990 to 2000. They examine three questions: I) are state-owned banks less efficient than private banks? II) are foreign banks more efficient compared to their domestic rivals? and III) are special finance houses (SFHs)\(^2\) less efficient than their conventional counterparts? Different methodologies (i.e. likelihood-based estimation classification method) including the traditional cost function approach and labour cost function analysis, are used to consider heterogeneity and thus, estimate efficiency scores for a

\(^2\) Special Finance houses (SFHs) are Islamic banks.
sample composed of 53 banks in which most of the banks in the Turkish banking system are represented. Loans are used as output in the cost efficiency model in order to represent banks’ role in financial intermediation through extending more loans. However, in the labour cost efficiency analysis model, labour is used as output to identify how efficiently labour-intensive loan officers operate in each bank within the sample.

The findings show that state-owned banks are not particularly inefficient in generating loans compared to the private ones. Nevertheless, they seem to be over-staffed and thus, less efficient in labour-hiring practices. Furthermore, foreign banks’ influence on the banking system overall efficiency seems indistinctive. The results reveal that SFHs are relatively efficient and tend to operate similar to domestic banks, meaning that the presence of SFH does not undermine the overall efficiency of the system. Their presence might serve a positive role by increasing financial intermediation, and hence SFHs attract customers who do not want to deal with conventional banks.

It is worth noting that, compared to previously reviewed articles El-Gamal and Inanoglu (2005) was the first study to use sophisticated methodologies to investigate the efficiency of Turkish banks overall and within different clusters in comprehensive panel data set.

Ozkan –Gunay and Tektas (2006) investigate the efficiency of Turkish non-public commercial banks over a period between 1990-2001 with an aim to analyse the performance of banks in the pre-crisis and throughout the crisis periods. Two
models are used with different composition of outputs with the objective of examining the sensitivity of banks efficiency to the different choices of output variables. The banks in the sample are clustered into three different categories: namely, Savings and Depots Insurance Fund (SDIF), private and foreign banks. The DEA approach is conducted to investigate the impact of the crisis on the performance of banks within each cluster. Input variables used in both models are personnel expenses, administrative expenses and interest expenses, whereas output variables are total deposits, total loans and total securities in model (A). However, in model (B), outputs are total interest income and total non-interest income.

The study finds that bank’s level efficiency shows a declining trend. The efficiency scores are sensitive to output choice and foreign banks in particular reveal high sensitivity. The crisis in 1994 has a significant impact on the deteriorating efficiency of the banks within the sample. This is especially the case when output variables are defined as income in Model B. Furthermore, SDIF banks reveal relatively low efficiency compared to the non-failure domestic banks either pre-crisis or during the crises periods.

Another study by Isik and Akcaoglu (2006) investigates the initial impact of financial liberalisation on the productivity and efficiency of “traditional” Turkish banks. A non-parametric Malmquist productivity index is used to measure the productivity and efficiency of 28 traditional banks during the financial liberalisation era of 1980-1990. Similar to Isik and Hassan (2002), and Isik et al

3 “Traditional banks” are “the banks that were existent before liberalisation and thus coming from “quiet life” in which they were protected against competition from internal and external market” (Isik and Akcaoglu, 2006).
(2002) there is evidence of upward trend in efficiency and productivity of the Turkish traditional bank. However, the main driver of productivity growth is efficiency increase rather than technological progress.

Denizer et al. (2007) covers a longer period analysis starting from 1970 to 1994 in order to reveal the long-term effects of liberalisation on banks’ efficiency with an aim to compare the banks’ performance in the pre- and post-liberalisation periods. The study utilises intermediation and production approaches concurrently to examine and compare bank’s performance in the production stage (collecting deposits using banks’ labour and physical capital) and intermediation stage (transforming deposits into loans and investments). In the production stage it is assumed that inputs variables are total bank’s resource, total personnel expenses and interest expense however, outputs variable are total deposits and income from charges and commission collected. Whilst, in the intermediation approach total deposits and operating expenditure excluding personnel expenses are inputs variables and total loans and interest commission and collected charges are outputs variables. The personnel expense is excluded from operating expenditure (input variable in the intermediation approach) to avoid double counting.

DEA is used in two-stage analysis is used to determine the relationship between production and intermediation functions of the banks’ operations in the pre- and post-liberalisation periods. In contrast to most of the findings in the previous reviewed studies, i.e. Zaim (1995), Isik and Hassan (2002), and Isik et al (2002), there are no consistency in the efficiency scores. Nevertheless, the intermediation approach efficiency levels seem higher than the production approach estimated
efficiency. There is no significant evidence of efficiency variation between the private and the state-owned banks. Denizer et al. (2007) argue that vulnerable macro-economic environment during the study period has significant impact on the Turkish financial system which possibly leads to their results. The authors also urge future research to consider further analysis for the Turkish banks’ performance in the years subsequent to 1994.

2.2.2. Efficiency and Productivity Studies in the Middle East and North Africa (MENA)

The MENA region has attracted little academic interest on the efficiency and productivity of the banks. This section will review only four studies from the MENA region. The first two studies reviewed include more than one country whereas the other two are country-specific studies.

Al-Jarrah and Molyneux (2004) use the Fourier-flexible cost function to investigate the cost efficiency performance of 82 banks from four Middle Eastern countries during the period 1992-2000 - these countries are Jordan, Egypt, Saudi Arabia and Bahrain. The study employs the intermediation approach. The inputs are deposits, labour, and physical capital. The outputs are total customer loans, all other earnings and off-balance sheet items. In addition to the inputs and outputs,

\[\text{The sample represents around 78\%, 88\%, 63\% and 55\% of the banks in these countries respectively.}\]
the study incorporates a variety of control\textsuperscript{5} and environmental variables\textsuperscript{6} to the model.

The results reveal that the estimated cost efficiency on average for the whole sample varies over time from 95\% in 1992 to 94\% in 2000. Islamic banks are the most cost efficient and the investment banks are the least cost efficient. The large banks are relatively cost efficient compared to the small banks. On country basis, banks in Bahrain seem to be the most cost efficient with 0.99. However, the Jordanian banks are the least cost efficient banks with 0.94. Banks in Saudi Arabia and Egypt attain an average cost efficiency of 0.97 and 0.94 respectively. Despite various economic and financial reform policies implemented by these countries, there is no significant improvement in their cost efficiency during the sample period.

Shams and Molyenux (2004) examine the efficiency of 93 banks in the Gulf Cooperation Council (GCC)\textsuperscript{7} from 1995 to 2000. The study estimates both cost and profit functions using the stochastic frontier techniques. The Fourier-Flexible functional form is used to construct the cost function and the standard and alternative profit function specification is used to estimate the profit efficiency. The study finds no significant discrepancies between the sample countries in terms of cost efficiency. The banks in Oman are the most cost efficient whilst the Qatari and UAE banks are the least cost efficient ones. In terms of profit inefficiency, the Omani banks are least inefficient whereas the Saudi and Bahraini

\textsuperscript{5} These variables are the size of loan loss reserves as percent of banks’ credit portfolio, the capital adequacy ratio and a time trend.
\textsuperscript{6} These include market structure, organisational characteristics, geographical segmentation and bank liquidity.
\textsuperscript{7} The GCC countries are Qatar, United Arab Emirates, Saudi Arabia, Bahrain and Oman.
banks are the most profit inefficient. Nevertheless, there is no significant differences in either cost or profit efficiency among the GCC countries. The study encourages greater consolidation in the industry between the GCC banks to improve the cost efficiency. Similar to Al-Jarrah and Molyneux (2004) the study urges the governments in the GCC to implement financial reforms that aim to foster competition and strengthen the banking system soundness.

A single country analysis on Jordanian banks is done by Maghayreh (2004). The DEA based Malmquist index is employed to investigate the effect of financial liberalisation on the Jordanian banks. Using the intermediation approach, the three inputs used are the number of staff, fixed assets and deposits. The three outputs are loans and liquid assets, off-balance sheet items, and other income.

The findings show that efficiency gains are attributed to the liberalisation policies, which is highly significant in the post-deregulation period. The results reveal an upward trend in both pure technical change and scale efficiency in all banks. However, pure technical and scale efficiency tend to be higher in large banks compared to the small banks. Moreover, the study extends the analysis to investigate the factors that may influence the efficiency. The bank size and profitability are significantly correlated with high efficiency performance. Competitive environment improves efficiency; hence banks with high market power are associated with high efficiency scores. However, banks with low loan loss provision tend to be more efficient. The banks with low capital adequacy ratio seem to be more efficient compared to those with lower ones, which implies that risk-averse banks appear to be inefficient.
Cook et al (2005) examine the impact of liberalisation and reform policies on the efficiency of the banking system in Tunisia. The study adopts the intermediation approach to estimate technical efficiency using non-parametric DEA methodology during the period 1992-1997. The results show overall stability in the financial system of Tunisia during a period characterised of financial crisis particularly in Asia. The liberalisation policies imposed by the International Monetary Fund (IMF) seem to have positive impact on improving the efficiency of the overall banking sector. However, the results show mixed effects across various categories of banks within the sample.

Private banks’ efficiency levels outperform their foreign and public rivals. Larger banks suffer from efficiency lag compared to the small banks. Most of the inefficient larger banks are public sector banks with an average efficiency of 31.75%. However, the small mostly private banks have an average efficiency score of 80%. Cook et al (2005) conclude that although there is a significant impact of liberalisation on efficiency progress of the overall banks in Tunisia, the reform policies are less successful in closing the efficiency gap between the state-owned, private and foreign banks. An earlier study on Tunisian commercial banks efficiency between 1980 and 1992 by Chaffai (1997) reveals that Tunisian banks suffer from high labour inefficiency. Chaffai (1997) introduces new econometric model to estimate input-specific technical efficiency in a panel framework [See Chaffai (1997:315-323) for more details].
2.2.3. Efficiency and Productivity Studies in other Emerging Economies Banking

This section will review the efficiency and productivity studies in other emerging economies, i.e. South East Asia (SEA), East Asia and emerging economies in Europe will be detailed.

2.2.3.1. South East Asia (SEA):

Gilbert and Wilson (1998) investigate the impact of deregulation and liberalisation policies on bank productivity on the Korean banks over the period 1980-1990. Non-parametric techniques are employed to estimate the Malmquist productivity index and decompose it into its components of technical efficiency change, technological change and scale efficiency change. The intermediation approach is adopted using labour, physical capital and purchased funds as inputs. Output variables are demand deposits, loans in domestic currency, loans in foreign currency, and loans by trust accounts. The results suggest that privatisation and deregulation policies enhance potential outputs as well as productivity growth among the Korean banks.

Hao, Hunter and Yang (2001) extend Gilbert and Wilson (1998) study by employing a different methodology with different time-period data set - a sample of 19 private Korean banks is used over the period 1985-1995 - not only to examine the productivity and efficiency during the period of study but to identify the key determinants of the Korean banks efficiency as well. Unlike Gilbert and
Wilson (1998) this study employs the SFA to estimate the cost efficiency of the Korean banks following the deregulation program initiated in the early 1980s and augmented in the early 1990s.

In contrast to Gilbert and Wilson, Hao, Hunter and Yang (2001) results reveal no significant sign of inter-temporal improvement in either the mean or the standard deviation of the cost efficiency index over the sample period. Hence, the deregulation did not have positive effect on improving the Korean banks cost efficiency. Hao, Hunter and Yang argue that the bulk of efficiency gains reported in Gilbert and Wilson (1998) are probably realised during the period immediately followed the deregulation between 1980 and 1985.

Leightner and Lovell (1998) investigate the impact of financial liberalisation on the productivity growth of the banking sector in Thailand during the period 1989-1994. The study employs the non-parametric approach to estimate the Malmquist Productivity Index and its components. Unlike other studies, Leightner and Lovell (1998) adopts a different approach from the three prominent and widely used approaches (intermediation, production and user cost approach)8 identified by Berger and Humphrey (1992) to estimate the productivity change.

Leightner and Lovell (1998) clarify that their approach is stimulated by the fact that the Thai commercial banks have a profit-oriented objective while the Bank of Thailand has other two objectives: first, fostering the economic growth and at the same time, preserving the safety and soundness of the banking sector. Therefore,

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8 For more details, see Berger and Humphrey (1992:246).
the study applies two empirical analyses; firstly to investigate the banks’ ability to pursue their profit maximization objective utilising three inputs - personnel expenses, premises and equipment expenses, and provision of possible loans loss to produce two outputs - net interest income and non-interest income. Secondly; to utilise the same inputs to specify the two outputs, namely credit granted and investment in securities aiming to examine the ability of the Thai banks to achieve the Bank Thailand goals during the liberalisation period.

The findings show that the Thai financial liberalisation is successful from the banks’ perspective. The majority of banks in Thailand adapt well to the financial liberalisation policies. Furthermore the Thai banks’ success in meeting their objectives (profit maximisation) is evident and improves throughout the period. However, small banks benefit less from financial liberalisation and the small foreign banks dominate all the Thai banks in terms of productivity progress.

Dugan and Fausten (2003) examine the impact of the deregulation and technological change on the productivity of Malaysian banks using the non-parametric Malmquist productivity index. The intermediation approach is applied to estimate the efficiency and productivity of the Malaysian banks during the deregulation period, 1989-1998. The inputs are personnel expenses and interest expenses and the outputs are investment securities, loans and advances and deposits from customers. The authors also perform a second-stage regression to examine the impact of size and market power on productivity.
The results show that there is deterioration in the Malaysian commercial banks’ productivity during the decade. The productivity estimates decline in the range between 3.3% and 5.6%, which implies that there are no significant benefits from liberalisation and innovation during the sample period. The results also reveal significant technological regress, which offsets the positive improvement in both pure technical change and scale efficiency. The second-stage regression results suggest that larger banks seem to experience faster productivity decline compared to small banks. However, productivity change varies with market power. It tends to vary negatively with specialisation and loan to asset ratio. The study concludes that regulatory and liberalisation reforms are not sufficient conditions for productivity environment.

Huang (2004) develops a model that is based on the safety-first rule under uncertainty to measure the risk premium and productivity that are subject to loan default and other investment risks. The study aims to examine the impact of two major banking reforms in Taiwan, in the years 1989 and 1997 on the industry’s total factor productivity and on the risk management behaviour after the Asian financial crisis. The parametric approach is used to estimate the translog cost function. The associated share equations are later used to estimate the total factor productivity, the rate of risk premium, and the scale economies of forty-eight banks from 1981 to 2000.

The results postulate that banks with efficient risk management practices obtain higher expected return though they are least likely to experience financial distress. Huang asserts that the reforms foster the competition hence the significant
evidence of productivity improvement in the government-controlled banks and the existing private-owned banks are evident. In contrast, new banks do not benefit from the financial reforms. Furthermore, there is significant evidence of increasing returns to scale in all categories of the Taiwan banking industry.


There is significant evidence supporting the hypothesis that exogenous factors influence the Hong Kong banking system. These are mainly macro-economic and housing factors. However, the effect of these factors varies among different sized banks and different institutional sectors. Another controversial finding in Drake et al is that the accession of Hong Kong to PRC, episodes of financial deregulation, and finally the 1997/1998 South East Asian Financial Crisis do not have any significant impact on the relative efficiency levels of the Hong Kong banking system.

Chen et al (2005) examine the impact of the deregulation program initiated in 1995 on the cost, technical and allocative efficiency of 43 Chinese banks over the period 1993 to 2000. The study applies the DEA to estimate the Chinese banks

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9 A number of reforms have been introduced during the period (1995-2001) with respect to financial liberalisation and deregulation of interest rate.
10 For more details, see Drake et al (2006:1447-1450).
cost efficiency by adopting the intermediation approach. The deregulation program initialised in 1995 has an initial significant impact on the overall efficiency of the Chinese banks. However, a decline in the efficiency levels is observed in particular, in the third and fourth year post-deregulation. Accordingly the authors suggest that the deregulation policies have a short-term effect on the Chinese banks efficiency improvement.

Furthermore, on average state-owned commercial banks obtain high efficiency levels compared to national joint-equity banks, regional joint-equity banks, and investment banks. The study also reports that both large and small banks are the most efficient ones. Chen et al argue that the reason behind the observed drop in the efficiency level of the Chinese banks in particular between 1997 and 2000 is due to both international and domestic factors. These include the Asian financial crisis and a remarkable increase in non-performing loans to state-owned enterprises.

Unlike Chen et al (2005), the study by Fu and Heffernan (2007) employs the SFA to investigate the cost efficiency levels in China’s banking sector during the period 1985-2002. The intermediation approach is used to estimate a translog cost function. The cost X-efficiency scores are obtained utilising three-disturbance models namely half-normal, exponential, and truncated-normal. The study acknowledges two stages of economic and financial reform, which may have significant impact on the banking system in China. The first stage is 1979-1992 which starts with a “two tier” banking system. The second stage starts in 1993
during which the State Council announces the decision on financial system reforms.

The results show that on average the X-efficiency in China’s banking sector ranges between 41% and 52%. Overall the joint-equity banks efficiency levels are found to be higher than those of the state-own banks. In contrast to Chen et al (2005), a variation in the impact of liberalisation is found on different ownership categories. The state-owned banks efficiency declines after the second stage of reform compared to the first stage efficiency levels. However, there is significant improvement in the efficiency levels of at least two of the joint-equity banks. Fu and Heffernan conclude that further liberalisation steps are needed to improve the efficiency performance of the Chinese banking sector. In particular they promote further either full or partial privatisation of state-owned banks, lifting the control imposed on interest rate, and reducing the state interference in lending policies.

In another study of Chinese banks, Kumbhakar and Wang (2007) analyse the impact of banking reform polices on the efficiency and productivity of the Chinese banks. The study exploits the flexibility of distance functions, which requires neither behavioural assumptions nor price information. Hence, they construct a translog input oriented profit function for the estimation of total factor productivity change of 14 banks in China during the period 1993-2002. The intermediation approach is adopted and the inputs are labor, total fixed assets, and total deposits plus total borrowed funds. The outputs are total loans and other earnings.
The results reveal the evidence of increasing returns to scale. Most banks are operating below their efficient scale. Similar to Fu and Heffernan (2007) and in contrast to Chen et al (2005), the joint-equity banks are on average 49% more technical efficient than the state-owned banks. The study extends the analysis by examining the role of bank characteristics and environmental forces in explaining technical efficiency. The results demonstrate that private ownership tends to stimulate technical efficiency progress. Moreover, risk avoiding banks (banks with high capital adequacy ratio) are associated with high levels of technical efficiency. However, large banks seem less efficient than small banks.

Unlike previous studies on Chinese banking, Kumbhakar and Wang (2007) find no evidence to support the view that liberalisation improves efficiency significantly. The results also reveal a moderate improvement in total factor productivity (TFP) growth. The TFP of joint-equity banks is attributed to scale economies, technical change and technical efficiency progress. In contrast, the TFP growth of state-owned banks stems mainly from the scale effect.

Williams and Nguyen (2005) examine the impact financial liberalisation, crisis and restructuring on bank performance and corporate governance in South East Asian region. The unbalanced data sample includes 231 commercial banks from five countries (Indonesia, Korea, Malaysia, the Philippines, and Thailand) between 1990 and 2003. This comparative study focuses on the relationship between the performance and corporate governance and other aspects inter alia liberalisation policies.
The study applies stochastic frontier methodology, and the Fourier flexible functional form to estimate an alternative profit function. The Battese and Coelli (1995) technical inefficiency effect model (one-step model) is employed to obtain the parameter estimates, which is in turn used to estimate the technical change and productivity for individual bank presuming banks to be financial intermediaries. Moreover, the study follows Berger and DeYoung (2002) and Berger et al (2004) to report rank order bank performance in order to circumvent some of the anomalies associated with the performance levels.

The results show that privatised banks obtain high levels of profit efficiency in the post-privatisation compared to the pre-privatisation levels. Williams and Nguyen (2005) however, argue that this refutes the claims that privatisation raises bank performance. Most of the privatised banks are the best performers before privatisation. Moreover, foreign banks tend to be selective in their acquisition decision. Hence, the acquired domestic banks by the foreign counterparts attain high levels of profit efficiency before the acquisition takes place. Surprisingly, however, there is not significant evidence that the foreign acquisition of the domestic banks improves the efficiency of those banks. Hence, the profit efficiency levels of these acquired banks in the post-acquisition are still far below their levels pre-acquisition. Williams and Nguyen (2005) elaborate that privatisation is associated with superior levels of profit efficiency and strong productivity performance.
2.2.3.2. *East Asia (EA) The Indian continent:*

Bhattacharyya et al (1997) examine the productivity efficiency of the banks with relation to liberalisation. The study investigates the efficiency of 70 commercial Indian banks during the early stages of financial liberalisation between 1986 and 1991. The study combines two approaches in two-step procedure; first the DEA is employed to estimate the technical efficiencies. Then, the second step uses the SFA to explain the variation in the calculated efficiencies from the first step.

The results reveal that both foreign-owned and private-owned banks achieve the lowest average of efficiency. The state-owned banks obtain the highest levels of average efficiency. The last two years of the study period exhibit considerable improvement in the efficiency levels of the foreign-owned banks in particular after 1987. Furthermore, the temporal performance balance demonstrates marginal improvement in the overall performance of the Indian banks. The public-owned banks show a significant decline in average efficiency whilst the foreign-owned banks achieve a remarkable increase in efficiency during the study period. The private-owned banks show almost no change.

The authors argue that liberalisation might lead to an overall improvement in performance. Yet it also creates winners and losers. Hence, the rise of the foreign banks performance was accompanied with a decline in the performance of the public banks. Bhattacharyya et al (1997) identify two reasons behind the improvement of the foreign-owned banks performance. The first is due to their ability to efficiently extend their small branch network into metropolitan areas.
rather than extending into rural areas. The second results from their efficient adaptation to an increasingly competitive environment.

Another study on Indian banks is conducted by Kumbhakar and Sarkar (2003). They analyse the relationship between deregulation and the TFP growth in the Indian banking industry using a parametric approach i.e. the generalised shadow cost function. The study covers the pre and post-deregulation periods over 12 years from 1985-1996. They employ the value-added approach which considers both deposits and loans as outputs. Furthermore the authors segregate the different types of deposits and treat each type as separate output.

The results show that there is evidence of moderate TFP growth for state-owned banks in the pre-deregulation period. In contrast, post-deregulation period witnesses a significant upward trend in productivity growth. The TFP growth of private banks tends to be slightly higher than the state-owned banks all over the period. The private banks achieve high level of TFP growth in the post-deregulation compared to the pre-deregulation levels for both private and state-owned banks TFP growth. The study concludes that the high dominance feeling of the public banks is the reason behind the inconsequential response to the deregulation measures compared to the private banks.

Iimi (2004) applies two parametric techniques to investigate the impact of liberalisation policies on banks performance in Pakistan. Zellner’s Seemingly Unrelated Regression (SUR) and the SFA are used to estimate the cost function.

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11 For more details see Kumbhakar and Sarkar (2003:408–413).
of 41 financial institutions in Pakistan using the intermediation approach over the period from 1998 to 2001. The study also aims to examine the degree of scale economies and degrees of scope economies.

The results demonstrate that Pakistani banking industry exhibits both economies of scale and scope, but there is a significant evidence of diminishing scale economies in particular for large banks. Furthermore, there is a significant cost-saving effect in increasing operational size of each category of financial services. The banks can expect cost advantage by augmenting their products and service portfolio.

Iimi (2004) argues that private banks in Pakistan operate with relatively large scale-economies but small economies of scope. However, at the product level, cost efficiency in private banks can be achieved by introducing new products. Also, the results indicate that privatised banks seem to be the most efficient ones compared to provincial, foreign and private banks. However, the state-owned banks have the lowest efficiency levels. Hence, a positive evidence of the usefulness of liberalisation polices. Moreover, the consolidation of small-and medium-size financial institutions needs to be encouraged to improve economies of scope and cost efficiency.

Ataullah et al (2004) conduct one of the few comparative studies in the literature to investigate the evolution of technical efficiency for the commercial banks in India and Pakistan. The study utilises DEA methodology to estimate the efficiency of the commercial banks in the two countries before and after
liberalisation during the period 1998-1998. Following Leightner & Lovell (1998), two models are constructed to estimate the efficiency score. Model (A) postulates that banks incur operating and interest expenses (inputs) to produce loans, advances and investments (outputs). Model (B) suggests that banks utilise the same inputs to produce interest and non-interest income (outputs).

The results show efficiency improvement in both countries’ banks, which is evident in both models. The improvement observed in the Indian banks’ technical efficiency stems from both scale efficiency and pure technical efficiency progress. Unlike India the improvement in scale efficiency is the main driver in the enhancement of the Pakistani banks’ technical efficiency in particular after 1995-1996. Despite both models demonstrate significant evidence of improvement in efficiency, the efficiency scores in model (A) are higher than model (B) results. The authors elaborate that the gap of efficiency scores obtained from the two models could be due to the existence of high non-performing loans in the asset portfolio of the banks in the two countries. Furthermore, the study claims that implementation of financial liberalisation policies are supportive in closing the efficiency gap between large and small banks.

Another study on Pakistani banks is conducted by Patti and Hardy (2005). They evaluate the impact of the 1990s financial and banking system reforms on the performance of Pakistani banks. They also examine whether the financial reforms affect various forms of bank ownership in different magnitude.
The study estimates both cost and profit efficiency following the methodology proposed by Berger and Mester (2003).

The results reveal that the first round of financial reforms (1991-1992) lead to a moderate increase in profits rather than cost reduction owing to the improvement in profit productivity and consequently increase in revenues. The state-owned banks tend to be the least efficient. However, the privatised banks seem to improve their efficiency instantaneously in the post-privatisation stage. The newly domestic banks tend to join the league of the most efficient ones and sometimes surpass the foreign banks in terms of cost efficiency. In general, the first round of reforms leads to superior bank performance. In contrast, there is no evidence of significant immediate positive impact of the second round on the banks’ performance. Patti and Hardy (2005) argue that it tends to be difficult to unravel the effects of privatisation from the effects of reforms.

Howcroft and Ataullah (2006) apply a DEA-type Malmquist total factor productivity index to examine productivity growth, efficiency and technical change in the commercial banks industry during the period 1992-1998 in India and Pakistan. Similar to Ataullah et al (2004) the study adopts the intermediation approach using two models following Leightner and Lovell (1998). The results reflect slow improvement in total factor productivity in both countries, implying a gradual or long-term impact of financial liberalisation. In the case of Indian banks, the loan-based and the income-based models produce total factor productivity change (TFPCH) of 4.6% and 4.2% respectively. However, the Pakistani banks’ TFPCH reveal lower improvement compared to the Indian case with 3.7% and
2.6% in the loan model and income model respectively. Public banks reveal poor response to liberalisation policies compared to their private counterparts in term of productivity improvement.

Ataullah and Le (2006) investigates the impact of economic reforms on the Indian commercial banks between 1992 and 1998. The study utilises the DEA method with output-oriented approach. Similar to Howcroft and Ataullah (2006) and Ataullah et al (2004) the study adopts two models to estimate the Indian banks efficiency. According to Attaulah and Le, the efficiency of the Indian banks has improved during the post economic reform period. The results assert significant evidence of overall efficiency improvement in different bank ownership forms (i.e. public, private and foreign banks). However, different models encompass different levels of efficiency for different banks.

Model (A) results suggest that public banks outperform both private and foreign banks in terms of efficiency despite the evidence of decline in the efficiency gap between public and private banks in particular during post economic reform period. In contrast, model (B) results show insignificant difference between the efficiency of foreign and public banks. Moreover, foreign banks efficiency seems to be higher in most of the years compared to the public sector banks.

Das and Gosh (2006) use the DEA to evaluate the efficiency of the Indian commercial banking sector during post-reform period, 1992-2002. The study employs three different approaches, namely intermediation, value added and operating approaches with an aim to investigate the possible efficiency changes
with different inputs and outputs selection. They extend the analysis by regressing the obtained efficiency scores from DEA against bank-specific variables (i.e. size, ownership, capital adequacy, non-performing loans and management quality).

Under the intermediation approach the Indian banks seem to have low levels of efficiency compared to the valued-added approach. Unlike the previous studies on India, the results fail to reveal any significant progress in the Indian banks’ post-liberalisation efficiency. Moreover, their results show high level of inefficiency during the liberalisation period. Das and Gosh (2006) argue that the inefficient use of valuable resources and the current scale of operation are the main sources of efficiency regress. Risk avoiding banks with high capital adequacy ratio are likely to be more efficient. Banks with high levels of non-performing loans are associated with low levels of technical efficiency. Das and Gosh conclude that the patterns of efficiency and technological change articulate with the rapid changes in the banking industry as response to the forces of deregulation.

Jaffry et al (2007) measure the impact of regulatory changes on the productivity and technical efficiency measures within the banking sectors of the 3 countries in the Indian sub-content over the period 1993- 2001. The countries are India, Pakistan and Bangladesh. The output oriented DEA and non-parametric Malmquist productivity index are used to estimate the efficiency and productivity of the banks. Furthermore, a second-stage Tobit regression model is employed to explain the trend in technical efficiency.
The results reveal that efficiency levels in both India and Pakistan improve over the period of analysis. In the case of Pakistan there is a significant drop in the efficiency levels in particular mid and late 1990s however, by the beginning of 2000 there is an observable sign of recovery. Also, a slight upward trend in the TFP levels prevails by the end of the period. Bangladeshi banks demonstrate high levels of TFP in the early and mid 1990s followed by downward trend particularly after 1999. The Pakistani banks suffer from a sharper decrease compared to Bangladesh in the TFP levels, again after the year 1999. Conversely, the Indian banks seem to have high levels of TFP with sharp upward correction after 1999 despite poor levels of TFP that prevails in the early 1990s. The results reported in the study fail to find any significant evidence of efficiency variation across banks of differing ages and sizes.

### 2.2.3.3. Emerging Economies in Europe:

Yildirim and Philippatos (2002) evaluate both cost and profit efficiency in transition economies. The study examines the efficiency level of commercial banks in 12 countries from Central and Eastern Europe\(^\text{12}\) (CEE) over the period 1993 – 2000. They employ the SFA and the Distribution Free Approach (DFA) to estimate banks’ specific efficiency using cost and profit functions from unbalanced panel data of 12 CEE. Adopting the intermediation approach, the study includes borrowed funds, labour and physical capital as input variables and loans, investments and deposits as output variables.

\(^{12}\) The countries included in their analysis are; Czech Republic, Estonia, Croatia, Hungary, Latvia, Lithuania, FYR of Macedonia, Poland, Romania, Slovenia, The Slovak Republic, and the Russian Federation.
The results show significant evidence of cost and profit inefficiencies in CEE commercial banks. On average, banks should decrease their cost by 23 to 28 percent to catch up with the best practice. However, the SFA profit inefficiency estimation shows that at least one-third of the banks are lost to inefficiency. The DFA approach suggests that almost half of the banks’ profit is lost due to inefficiency.

Yildirim and Philippatos (2002) extend their analysis by investigating the cross-sectional determinants of bank-specific inefficiency. A regression analysis is employed to regress the inefficiency scores obtained from the SFA model against a number of financial and structural variables. The second stage results suggest that large and well-capitalised banks seem to be more efficient. However, banks with higher levels of non-performing loans are associated with lower levels of efficiency. The analysis of the market structure impact on bank-specific efficiency reveals that the higher the competition, the lower cost and higher profit efficiency respectively. The study elaborates that favourable economic environment tends to improve only cost efficiency. Moreover, foreign banks tend to outperform both private and state-owned banks in cost efficiency however, they seem inefficient in producing profit compared to their private and state-owned peers.

Hasan and Marton (2003) analyse the Hungarian banking sector experience during the transitional process from a centralised economy to a market-oriented system. The study employs the SFA to estimate profit and cost inefficiency. The
results show steady progress in both cost and profit efficiencies levels of the Hungarian banks. The competition emerges from the skilled and experienced foreign banks which have a positive impact on the banking sector efficiency.

The banks with foreign involvement seem to be significantly more efficient compared to the domestic counterparts. Furthermore, the institutions that acquired domestic banks are associated with lower levels of efficiency. The authors argue that the experience of foreign banks in Hungary is different when compared with other countries. The foreign banks manage to achieve lower level of inefficiencies by transferring their comparative advantages and exploiting the market conditions due to the idiosyncratic features of local customers and services delivery systems.

Weill (2003) analyses the influence of nature of ownership on the cost efficiency of banks in two transitional economies, namely the Czech Republic and Poland. The study employs two-step approach. In the first step the cost efficiency of 47 banks is estimated from both countries in the year 1997 following Mester (1997). The second step uses Tobit regression model to investigate the role of explanatory variables on the efficiency gap between domestic and foreign-owned banks. The study finds higher cost efficiency scores in the foreign-owned banks compared to the domestic-owned banks. The foreign banks benefit from technology transfer, and subject to better corporate governance by foreign shareholder. The study finds improvement in banks performance directly related to the degree of openness of the banking sector to foreign capital.
Matosek and Taci (2004) investigate the cost efficiency of Czech banking system in the 1990s. The study applies the parametric stochastic distribution free approach (DFA) to estimate the cost function. The intermediation approach is used to specify three inputs and two outputs. However, two basic models are used in the estimation one of which the deposits are treated as output and as input in the second model. The results indicate that the Czech banks efficiency levels have improved during the study period. The less efficient banks are forced to exit the market and consequently leave the market with the relatively efficient banks. The foreign banks on average outperform the domestic counterparts.

Matosek and Taci (2004) emphasize the importance of efficient supervision and regulatory capacity in the case of liberalising new entries into the banking system. Hence, the strong supervision and legislative environment would likely discourage the entry of inefficient banks. The privatisation and market openness to foreign banks are likely to pressurise the existing banks to reduce cost or voluntarily merge with more efficient banks or finally exit the industry.

Kasman (2005) examines the cost efficiency and scale economies of two transitional countries banking sector namely Poland and Czech Republic during the period 1995-2000. The study employs the SFA to estimate the cost function and economies of scale of thirty-five polish banks and nineteen Czech banks with country-specific environmental variables. The results for the whole sample suggest that an average bank could improve its cost efficiency by 18.6% to catch-up with the performance of the best practice bank. Polish banks seem to be more efficient than the Czech banks. There is no clear evidence of the relationship
between size and cost efficiency. Large banks tend to be more efficient than the small banks. Kasman (2004) expound that the degree of foreign competition has positively affected the banking sector performance. Thus, domestic banks are significantly less efficient than foreign-owned banks in the Czech banking system. There is evidence of economies of scale in both countries.

Bonin et al. (2005) investigate the effects of ownership, particularly strategic foreign owner on banks’ efficiency in eleven transition countries in an unbalanced data set which contains 225 banks and 856 observations during the period 1996-2000. The study employs the stochastic frontier techniques to estimate both profit and cost efficiency. The study finds that foreign ownership leads to more efficiency in the transition countries. Foreign banks in general are more cost efficient and provide better services compared to domestic counterparts. In particular, those are owned by strategic foreign-owner. The banks possibly to be privatised in the future within these transition countries are less cost efficient compared to the privatised ones.

Kraft et al (2006) apply stochastic frontier model with a Fourier-flexible form and a truncated normal distribution to estimate the cost efficiency of commercial banks in Croatia between 1994 and 2000. They find that liberalization in the form of opening the banking market to new entrants is not always a productivity exercise. The results reveal that the period witnesses massive liberalisation activities in the banking sector during which almost all the state-owned banks were privatised, the entrants of the first foreign banks, a systemic banking crises and the privatisation of the largest state-owned banks to foreign owners.
Kraft et al (2006) find evidence of lower efficiency levels of the private banks and the newly privatised banks compared to the state-owned efficiency level. There is no sign of efficiency gains in the first two/three years particularly after the privatisation program. There is significant evidence of convergence towards higher level of efficiency in the whole banks by the year 2000. Consistent with most of the previous studies, this study also finds that large banks tend to be more efficient than small banks. Finally the results reveal that failed banks are associated with lower efficiency compared to those banks that survived or left voluntarily through mergers. Moreover, foreign banks seem to have strong efficiency advantages compared to its domestic counterparts.
2.3. Conclusion

The present chapter has reviewed various studies which investigate banks’ efficiency and productivity in emerging economies, particularly during periods of financial liberalisation and deregulation. These studies collectively covered the analysis of the banking sector experience during and in the post financial reform periods in twenty-three countries excluding the transitional economies groups. Forty-one articles in total were reviewed, of which twelve studies on Turkey, four studies on MENA and GCC region, ten on South-East Asian countries, nine on East Asian countries, and seven on emerging economies in Europe.

It is worth to note that twenty-one studies employed the non-parametric technique DEA, seventeen studies employed the SFA and only one study used the DFA. The remaining two studies of the reviewed literature used two methodologies together (i.e. DEA and SFA, DFA and SFA). The majority of these studies were inspired by the wave of reforms on liberalisation, deregulation and banking sector restructuring. For instance Bhattacharyya et al. (1997), Leightner and Lovell (1998) and Gilbert and Wilson (1998) are of the early studies that addressed the impact of deregulation and liberalisation on banks efficiency and productivity in Asia’s emerging economies, in particular India, Thailand and South Korea. Similarly, Zaim (1995) is the first study to investigate the impact of the liberalisation on the Turkish banks efficiency. In the MENA and GCC regions Chaffai (1997), Al-Jarrah and Molyneux (2004), Mohamed and Molyneux (2004) are among the first published studies.
In many cases, liberalisation and deregulation policies seemed to stimulate competition in the banking sectors. The banks tend to respond positively to a more liberal environment, banks’ efficiency and productivity significantly improved during and post-liberalisation periods *inter alia* [among others see Chaffai, (1997); Leightner and Lovell, (1998); Isik and Hassan, (2002); Bhattacharyya et al. (1997) and Kumbhakar and Sarkar (2003)].

In some countries, liberalisation policies tend to have short-term effects on improving banks’ performance. For instance, soon after financial liberalisation reforms were introduced, Turkey experienced financial crisis in the post-liberalisation period. It seemed that the negative impact of the crisis outweighed the efficiency gains obtained during post-liberalisation period (Denizer et al., 2007 El-Gamal and Inanoglu, 2007 and Demir et al. 2005). Hao, Hunter and Yang (2001) find that the deregulation did not have a positive effect on improving the Korean banks’ cost efficiency. They argued that the bulk of efficiency gains reported in Gilbert and Wilson (1998) were probably obtained instantaneously in the post-deregulation period. Dugan and Fausten (2003) revealed deterioration in the Malaysian commercial banks productivity in the post-liberalisation era. Similarly, Kumbhakar and Wang (2007) found no evidence to support the view that liberalisation significantly improved efficiency in Chinese banks.

The results obtained from the reviewed studies on the impact of liberalisation on different ownership groups are also mixed. For example, liberalisation creates winners and losers (Bhattacharyya et al. 1997). In some cases the rise of the foreign banks performance was accompanied with a decline in the performance of
the public banks, as observed in Bhattacharyya et al. 1997 for Indian banks. On the other hand, Das and Gosh (2006) failed to find evidence of efficiency progress in the post-liberalisation era for the same country. Isik and Hassan (2003) and Leightner and Lovell (1998) found that the magnitude of liberalisation impact varied among the different forms and showed higher impact on foreign banks efficiency productivity compared to state-owned and private banks in Turkey and Thailand respectively. Cook et al (2005), on the other hand, found that in Tunisia private banks outperformed foreign banks in the post-liberalisation period. Zaim (1995) found that state-owned banks outperformed the private banks efficiency in Turkey.

Moreover, there are mixed findings in the reviewed literature about whether privatisation helped the privatised banks to improve performance or not. Williams and Nguyen (2005) found that most of the privatised banks were the best performers before privatisation. Moreover, foreign banks tend to be selective in their acquisition decision. They tend to acquire banks with high profit efficiency. In contrast, Gilbert and Wilson (1998) found that privatisation and deregulation policies enhanced productivity growth among the Korean banks. Iimi (2004) indicated that privatised banks seemed to be the most efficient ones compared to provincial, foreign and private banks in Pakistan. In some studies, the privatised banks seemed to improve their efficiency instantaneously in the post-privatisation period (Patti and Hardy, 2005).

In the literature, there are interesting results when bank sizes and their performance are compared. For example, banks with different sizes may tend to
behave differently particularly during periods of changes in economic policies. Demir et al. (2005) found that size matters and thus, larger banks tend to be more efficient. Large banks were relatively cost efficient compared to the small banks (Al-Jarrah and Molyneux, 2004). Similarly, pure technical and scale efficiency tend to be higher in large banks compared to the small banks (Dugan and Fausten, 2003). However, there are studies which report that large banks seem to be less efficient than small banks (Kumbhakar and Wang, 2007).

To sum up, there is no consensus about the impact of liberalisation on banks performance in emerging economies. In some countries, the banking sector benefited from liberalisation policies whereas in others, the sector seemed not to be affected or deteriorated. The same conclusion also applies to bank ownership forms and size. Nevertheless, it seems that most of the studies coincided with a significant conclusion that a sound financial sector and efficient regulatory system is an essential environment to harvest positive outcomes from the financial liberalisation and deregulation. It is highly important to note that there is still a gap in the literature of bank performance studies yet to be filled by further studies covering several dimensions in this vein, particularly in developing countries (i.e. Africa, Middle East, Middle Asia, and South America).
3. Chapter three: Egypt and Turkish banking sectors

3.1. Introduction

This chapter details the evolution of recent developments in the banking sectors of the two emerging economies; Turkey and Egypt. These countries have similarities not only on the level of economic development but also on the structure of their societies. In general, the last two decades witnessed periods of rapid financial liberalisation, privatisation and consolidation in both countries with similar aims, i.e. to diminish the state control in the economy and maximise the private sector contribution to economic growth, stimulate foreign direct investment and pave the way to flexible international trade. This chapter will mainly focus on the banking industry analyses for both countries with reference to financial liberalisation reforms.

Financial system reform policies were often proposed as part of broader economic reform and stabilisation policies by prominent international financial institutions (Arestis, 2005). To improve economic growth and promote market oriented policies, both countries implemented reform polices proposed by the IMF and World Bank. Turkey first launched its Structural Adjustment Programme (SAP) in the 1980s. Egypt embarked on the Economic Reform and Structural Adjustment Programme (ERSAP) in the early 1990s.

In Turkey and Egypt financial intermediation activities are primarily undertaken by the banks. Reforms tended to be bank-centred as banking sectors play a vital
and almost the only role in the financial systems likewise many other emerging economies (Beim and Calomiris, 2000). Therefore, in both countries reforms were introduced for the banking sectors to stimulate competition and improve bank efficiency. Liberalisation and reform policies took the form of abolishing interest rate ceilings, diminishing state intervention in directing credit, reducing reserve requirements, freeing the flow of capital, removal of foreign entry barriers and privatisation of state-owned banks.

This chapter is organised as follows. The next section details the evolution of banking industry in Egypt and provides an industry analysis for Egyptian banking sector with reference to liberalisation reforms. In the same way, the third section focuses on Turkish banking industry and discusses the evolution of Turkish banks, liberalisation policies and financial crisis experience of the Turkish financial system. In the fourth section, a comparison between the two countries is introduced. Finally, the last section concludes.
3.2. Industry Analysis Egyptian Banking Sector

3.2.1. Historical background:

The evolution of the Egyptian banking industry started in 1856. The establishment of commercial banks as the first financial institutions appeared in response to economic development in Egypt. At the end of the eighteenth century the banking industry faced three crises, which left the banking system in vulnerable status (1879, 1911 and 1939)\(^\text{13}\). At the time the banking system suffered from the absence of a controlling and monitoring institution until the establishment of the National Bank of Egypt (NBE)\(^\text{14}\) in 1898. The NBE acted as the government bank and financial advisor despite the fact that the bank was totally owned by foreign capital. Foreign banks that primarily focused on financing agricultural activities dominated the banking sector.

After the 1919 Revolution, the banking system witnessed new developments and challenges. It was felt necessary to establish Egyptian banks solely owned by Egyptian capital. The establishment of Misr Bank “Banque Misr” (MB) in 1920\(^\text{15}\) was a result of the 1919 Revolution and the need for industrial credit. The subsequent twenty years of Misr Bank’s establishment witnessed remarkable progress.

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\(^\text{13}\) Debt crisis was in 1879; Speculation and market failure were in 1911; Banks-run crisis was in WW II 1939.

\(^\text{14}\) The National Bank of Egypt (NBE) was established in 1898 as a commercial bank with a capital of EGP 1 million. The NBE was owned and managed by British citizens. In addition to acting as the Government bank and the financial advisor, the NBE was exclusively privileged to issue banknotes according to the Khedival decree which were introduced for the first time in Egypt. However, the NBE did not function as the Bank of banks. Instead, it participated in granting short-term finance to cotton cultivators similar to other commercial banks.

\(^\text{15}\) Bank Misr was established with an initial capital of EGP 80 thousands, later raised to EGP1 million, the foundation of the bank was accompanied with the restricted condition that only Egyptians are allowed to subscribe in the Bank’s capital and be member of the board of directors.
growth in its assets and deposits. The Bank had government support demonstrated by the allocation of Post Office savings accounts to the MB in 1927. The Misr Bank became the second bank after the National Bank of Egypt (NBE). The MB played an impressive role in supporting domestic industries through its affiliate companies. After the outbreak of World War II most short-term depositors withdrew their funds from the Post office deposit. Nevertheless, the bank-run crisis in 1939 did not severely affect the bank. The NBE intervened (acting as government bank) to alleviate the banks’ difficulties by guaranteeing its deposits and instructed the NBE to provide the banks with the required liquidity.

After the World War II the need for industrial credit re-emerged particularly to finance small and medium-sized enterprises. In 1947 the government established the Industrial Bank (IB) in order to foster the industrial sector and to provide small and medium-sized industrial enterprises (SMEs) with their needs for finance. In the event, the IB could not achieve its main aim. Instead of the SMEs most of its financing was directed to large projects to avoid the risk associated with small and medium size activities.

3.2.2. Nationalisation and Financial Repression

In the year 1952, particularly in July 23rd a group of military officers known as the Free Officers launched a revolution against the monarchy in Egypt. The new regime adopted a socialist and nationalist ideology. The implementation of

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16 The affiliate companies reached to 27 in 1940. These companies were diversified among several industries (i.e. spinning and waiving, dairy products, airlines, and insurance).

17 The 1952 Revolution by a group of army officers (Free officers move) led by Lieutenant Colonel Gamal Abdul Nasser whom later became the President of the Arab Republic of Egypt in 1954. His leadership era is widely known as Nasser’s regime.
socialist policies started with land ownership reform. The government redistributed the ownership of land among farmers. In addition to adapting the former Soviet Union experience by building of massive heavy industrial base projects, the Nasser regime commenced its first instance of nationalisation in 1956 when the system announced the nationalisation of Suez Canal Company.\(^{18}\) The nationalisation decision was a result of the conflict between the World Bank and the Egyptian government at that time.

The inadequate finance offered by the WB towards the Aswan Dam (High Dam), forced the government to desperately seek for alternative sources of finance. Nationalising the Suez Canal Company seemed the only solution to exiting this predicament. At that time the government believed that building the dam would help the country to achieve higher productivity in the agricultural sector. Furthermore, electricity generated from the dam would foster industrial plans. Consequently, achieving government’s ambitions would shift Egypt into a new industrial era. The nationalisation of Suez Canal Company resulted in a military assault led by Great Britain and its allies, France and Israel. Following a cease-fire and during the subsequent war years, a comprehensive wave of nationalisation started to strike most of the economic sector’s enterprises. In particular these enterprises were formerly owned by either high net worth domestic or foreign private capital.

The period between 1955 and 1965 can be considered a transition period in the Egyptian economic history during which the Egyptian economy witnessed

\(^{18}\) The majority of Suez Canal Company was owned by the British and French capital (i.e. more than 80%).
dramatic structural transformation from private sector to public sector dominance (Ikram, 1980). The nationalisation of banks was backed by Law 22 in 1957. The Law stipulated that all the British and French banks should be confiscated. The remaining had to take the form of joint stock companies within five years. The paid in capital should not be less EGP500 thousands Egyptian pounds, in the form of shares fully owned by Egyptians. Consequently, the small size foreign banks, which could not fulfil the new law’s capital requirements either joined the Egyptian banks or closed down. As a result of these determinants, the number of working banks dropped from 35 banks in 1957 to 27 banks in 1958 (Mohieldin, 1998). In 1957, in order to impose more control on the credit market the government granted the NBE (the bank acting as a Central Bank) more power under the provision of Law No. 163 of 195719.

In the early 1960’s Egypt effectively started a nationalisation policy following the economic system of the former Soviet Union. The banking sector was among the many economic sectors affected by this policy. According to the government nationalisation of the banking sector was a must to guarantee a sustainable flow of loans to support the economic sectors, which were dominated by state-owned enterprises at that time (Mohieldin, 2000).

Thus, the Egyptian banking sector was transformed from being dominated by private sector enterprises to being gradually dominated by public sector enterprises. Under the Law 40 of 1960, both NBE and the Misr Bank were nationalised by converting their shares into government bonds with an option to

19 For more details, see Mohieldin (2000).
be redeemable after a minimum of 12 years. The nationalisation of NBE was justified by the fact that it was the state Central Bank. In contrast the nationalisation of Misr Bank was mainly because of government concern to obtain full control of its affiliated companies.

In 1961, all banks were nationalised under the provision of Law No 117\textsuperscript{20}. The government claimed that this was necessary to safeguard the creation of a centrally planned economic system. The government divided the NBE into two banks of which one bank was kept under the same name and carried on its activities as a state-owned commercial bank. The other one was called the Central Bank of Egypt (CBE) to act as the Central Bank. The aim of the CBE was to undertake the role of controlling and supervising the banking units’ activities. In 1963 the “Public Organisation of Banks” (POB) was formed to assist the CBE in controlling and supervising the banking units. Later in 1964, in order to prevent dualism and conflicts in activities the government abolished the POB and hence, the CBE took over its supervisory role. By the year 1974\textsuperscript{21} there were only four commercial banks and three specialised banks in addition to three unregistered banks, which were the only banks established during the period\textsuperscript{22}.

It can be surmised that during the period between 1957 and 1971, the Egyptian banking system was ruled under repressive polices represented in extensive governmental intervention in directing credit. Undermining the role of the private sector in economic growth and appraising the public sector role, there was the

\textsuperscript{20} It was one of a group of laws that had been introduced by the government during the early 1960s to nationalise the main economic establishments in the country.
\textsuperscript{21} See Table 1 for the structure of the Egyptian banking sector.
\textsuperscript{22} Exemption from registration with CBE means exemption from banking, credit and exchange rate.
existence of interest rate ceiling, negative real interest rate, state ownership and micromanagement, high reserves requirement, restrictions to entry, constrains of international capital inflow and outflow, and disintermediation.

3.2.3. Pre-Liberalisation (Liberalisation attempt “Open door policy”)

The Egyptian economy experienced two consecutive wars within a six year period. The two wars in 1967 and 1973 severely depleted the economic resources and left the country with a massive trade deficit, weak infrastructure and overall an ailing economy. The country’s economy could be described as terribly exhausted, with most of the resources directed to the army. In 1974 the government realised the need of comprehensive finance, mainly to reconstruct the immense damage and the devastating consequences on the whole economy caused by the two wars. Government embarked on a new reform policy namely the open-door policy (Infitah). The policy had a controversial outward vision compared to the previous regime’s closed door policy. The Infitah, open-door policy was aimed to encourage private sector and foreign direct investment to invest in the country. Thus, the need to improve the financial system structure was essential to attract new sources of finance and stimulate private and foreign capital to participate in the development process.

23 In 1970 a new government came to the power under the rule of new president Mohamed Anwar El- Sadat who was a member of the free officers’ move after the former president Gamal Abd El Nasser passed away in the same year. Shortly in October 1973, Egypt went to another war with Israel to end the six years’ occupation of the Sinai Peninsula. The occupation was as a result of the Egyptian army defeat in 1967 war with Israel.
The *Infithah* policy was accompanied with significant flow of external resources represented in oil exports revenues, abroad workers’ transfer of funds, tourism revenues, Suez Canal proceeds and foreign assistance - all of which had great impact on the structure of the banking system.

The investment Law 43 for 1974 and its amendments by Law 37 for 1977, abolished entry barriers previously imposed on foreign banks during the early 1960’s. Government launched the new banking Law enacted in 1975 (Law 120/1975. Thereupon, a new definition of banks’ nature and operations took place. It identified three types of banks, namely Commercial banks, Business and Investment banks and specialised banks24. The Law 120 of 1975 authorised the establishment of private, joint venture, foreign bank branches and offshore banks in order to promote foreign investment and provide outstanding banking services to the foreign investors. The banking industry witnessed a dramatic increase in the number of total banks and branches. The number of banks inclined from 27 banks in 1975 to 51 and 81 banks in 1981 and 1985 respectively25.

Despite government’s attempt to liberalise the banking sector, it still remained dominated by state-owned banks. To take advantage of the restrictions imposed on private and foreign banks, state-owned banks expanded their branch network. Hence, the market share of the four major state-owned commercial banks was 73% in terms of total deposits. The dominance of state-owned banks and continuation of directing credit policies led to a prioritisation of lending towards public sector enterprises/projects. Consequently, the quality of loan portfolios deteriorated due to poor underwriting capabilities in addition to the inefficiency

24 See El-Shazly (2001)
25 See Appendix (1) table (1)
and poor productivity of the borrowers. The state-owned banks were characterised by poor corporate governance, inefficiency in allocating resources, undercapitalisation and were overstaffed with unqualified personnel and mismanagement (Caprio and Cull, 2000). In contrast, the private sector banks had high qualified personnel, and efficient management. However, private banks also suffered from poor corporate governance represented in what was called “relationship banking”. Another form of poor corporate governance was the conflict of interest by favouring corporate or conglomerates, which have major shareholding in the banks (Arestis, 2000).

In summary, the legacy of the preceding three decades of management inefficiency, overstaffing, directed credit and interest rate control remained outstanding. This left the private and foreign banks in unfair competition. The banking system could be described as being only partially liberalised at this stage. The most effective liberalisation policies started in the early 1990’s (Mohieldin, 2000), (El-Refaie, 1998), (Abu Ali, 1998), and (Omran, 2007).

**3.2.4. Financial Liberalisation 1991**

After the first Gulf War of 1990 Egypt received significant financial assistance from both the Gulf States and the USA as a reward for its role in the war. The financial assistance represented in the cancellation of USD$ 13 billion of its total external debt of USD$ 51. Furthermore, Egypt was granted debt and debt service relief by the Paris Club creditors of around 50% of its outstanding debt over three phases through the mid-1994. The aforementioned financial assistance was
accompanied with higher oil export prices and a decrease in the main import prices. This helped the country to overcome diminishing effects on the economy caused by the Gulf War crises\textsuperscript{26}.

The Egyptian economic indicators improved, represented in high foreign currency reserves and increased creditworthiness. The IMF and the World Bank encouraged the government to embark on a comprehensive economic reform program called the \textit{Economic Reform and Structural Adjustment Programme} (ERSAP) in 1991. The ERSAP was aimed at transforming the economy towards market forces and stabilising both the monetary and fiscal policies, reducing government expenditure, controlling inflation, and reforming the exchange rate system. Furthermore, the programme had the objectives of improving efficiency and productivity and enhancing market competition through significant incentives to private sector and foreign investors (Mohieldin and Nasr, 2003).

The main objective of the ERSAP is summarised by the IMF (1991) as quoted in Mohieldin (1998) is; \textit{“to create, over the medium term, a decentralised market based outward-oriented economy where private sector activity will be encouraged by a free, competitive, and stable environment with autonomy from the government intervention. For this purpose, controls on economic activity and investment are to be dismantled and primary reliance placed on market forces for resource allocation”\textsuperscript{27}. “}

\textsuperscript{26} This represented in massive returns of expatriates from the Gulf region and hence the economy experienced a huge decline in foreign currency transfers, decline in both Suez Canal and tourism proceeds and unfavourable investment outlook.

\textsuperscript{27} IMF (1991:8). Also, for more details, see ERSAP, World Bank (1991) and (1992) and IMF (1991) and (1992).
The banking sector reform in the early 1990s took three main forms; first the liberalisation of the financial variables, which aims to improve the regulatory framework and consider the privatisation of state-owned banks. The banking sector witnessed the removal of interest rate ceilings in early 1992. Later in the same year, the CBE abolished the lending interest ceiling and reduce the required reserves. The government promised to minimize the intervention in credit allocation.

The second form of liberalisation was the introduction of new prudential measures represented in capital adequacy, asset classification and provisioning which came after the resolution of liquidity requirements for both domestic and foreign currencies in 1990. The reserve requirements were reduced from 25% to 15% of total deposits in Egyptian pound. However, the banks continued to hold 15% of total foreign currency deposits. The liquidity ratio reduced from 59% in 1992 to 56.7%, 34% in 1997 and 2000 respectively. In order to overcome the problem of undercapitalised public sector banks the government injected EGP 1.3 billion into the public sector banks consequently the capital adequacy ratio of public banks improved from 1.7% in 1990 to 4.7% in 1991. The capital adequacy ratio started to decline the year after. However the ratio started to recover and reached 4.5% in 1999 (Mohieldin and Nasr, 2003)\(^{28}\).

The third form of liberalisation policies was selling the public sector shares in twenty-three join venture (JV) banks to the private sector. In late 1994 the government required the four major state-owned banks to reduce their ownership

\(^{28}\) See Appendix (1) table (2)
shares in JV banks to less than 51%. Further reduction was imposed on state-owned banks in 1996 to reach maximum 20% of their capital (Omran, 2007). The government allowed the majority of foreign ownership in JV banks to more than 49% under the provision of Law 97 of 1996. The same Law also freed the charges and fees to be determined by the banks. The Law 155 of June 1998 allowed the private sector to participate in state-owned bank ownership. However, until the year 2002 no action has been taken by the government to privatise any of the state-owned banks\textsuperscript{29}.

Since the liberalisation and reform program in 1991, there has been a notable improvement in the Egyptian banking sector overall. The banking sector became more competitive with more contribution from the private sector banks. Many banks were transferred to private sector ownership; more foreign interest in Egyptian banks ownership emerged especially after the activation of capital market and stock market. The state-owned banks lost some of their market shares to private sector, JV and foreign banks. The state-owned banks’ total assets declined from 74.6% in 1993 to 63.1% in 1999. And the total deposits declined from 75.5% in 1993 to 66.1% in 1999. Similarly total loans dropped to 59% in 1999 compared to 92.6% in 1993\textsuperscript{30} (Omran, 2007).

Egypt experience with financial liberalisation has been a success. Unlike, many emerging economies until the year 2002 Egypt did not experience any bank crisis. In contrast, some emerging economies suffered from economic or financial crises in post liberalisation stages despite the positive impact of efficiency and

\textsuperscript{29} See Appendix (1) table (3) and table (4)  
\textsuperscript{30} See Appendix (1) table (5)
productivity improvement on their banking systems (Beim and Calomiris, 2000). The reason for the Egyptian success story in implementing the liberalisation policies might be the gradual and cautious approach adopted by the government. Such policies were implemented in phases. The first phase took place from 1991-1996 and it covered monetary and fiscal policy management. The second phase took place after 1996 and covered macro-economic stability (Caprio and Cull, 2000).

According to Arestis (2001), the Egyptian experience is different from other emerging economies because no serious post liberalisation banking or financial crises had occurred - the cautious approach to implement the liberalisation policies by the Egyptian authorities along with the institutional enhancement process explained the successful experience. The key success words to describe the Egyptian experience in implementing the liberalisation policies were that “gradualism” and “caution” (Caprio and Cull, 2000). Aresties (2001) also explained that the reform has been slowly or cautiously implemented and listed a number of financial reforms to be done.

There is consensus in the literature regarding the success of financial liberalisation to reform the financial sector in Egypt. However, most of the studies emphasise that there is more to be done by the government to improve the efficiency and thus strengthen the banking sector. For instance the slow down in privatisation process deters innovation and competitiveness in the banking sector. More prudential measurements and more regulation are needed to improve transparency, risk management and corporate governance (Mohieldin, 2000), (El-Refaie, 1998), (Abu Ali, 1998), (Caprio and Cull, 2000), (Arestis. 2000).
3.3. Industry Analysis - Turkish Banking Sector

3.3.1. Historical Background:

Turkey gained its independence in 1923. Immediately after independence the Turkish government implemented a liberal economic reform policy to promote the role of the private sector in the economy. The banking sector was comprised of 35 banks of which 22 were owned by Turkish nationals and 13 were foreign owned, making a total of 439 branches during the period between 1923 and 1950s. Most of the foreign banks at that time were involved mainly in providing financial services to the foreign companies in the country. On the other hand the local banks were small in size and weaker in their structure compared to the foreign banks. However, small banks carried the burden of providing financial services to the local companies (Nas and Odekon, 1988).

During the early 1930s the state implemented a policy of heavy industrialisation. The local banks at that time could not provide sufficient financial support and the capital needed by these industries. Consequently the government established state owned banks and specialised banks to support its industrialisation program. The world economic depression of the 1930s affected the Turkish economy as it did in other economies. Many of the private banks did not survive the economic situation and left industry to the domination of state owned banks. As a result the number banks reduced to 40 by 1945.

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31 Four state owned banks were established at the time (Nas and Odekon, 1988).
During the early 1960s government moved to decrease its influence by promoting the private sector role in the banking sector. The government aimed to enhance competition and promote efficiency in the sector. However, the country was hit by another economic depression before these reforms could go far. Yet again the small banks terminated their operations through either liquidation or merging with other banks. This resulted in the disappearance of 15 small banks between 1960 and 1964 and the number of banks reduced to 49 banks (Tarimcilar, 2000). The government’s attempt at reforms failed and eventually the state had to intervene to rectify the situation caused by the economic depression. According to Denizer (1997) in 1960s the banking system witnessed significant changes represented in an increased state role in credit allocation, and interest rate control. The government rather focused on the public banks in order to support its industrialisation program. The private banks were not supported and consequently many of the small banks left the industry.

3.3.2. Financial Repression 1960 – 1979

During the 1960s and 1970s the Turkish banks operated under a repressed system and the banking sector was characterised by government intervention in directing credit, controlled interest rate, high reserve requirement, highly segmented and restricted entry (Denizer, 2002). Barriers to entry were imposed on either domestic or foreign banks. As a result state owned banks dominated the market. The four leading banks held more than 50% of both total assets and total deposits (Atiyas, 1989). The nominal interest rate was kept artificially low by the
government but the real interest became negative because of high inflation rates (Fry, 1980).

The existing banks during that time expanded their branch networks in order to reap the benefits of deposits due to rising inflation. The excessive number of branches and their high cost resulted in an inefficient banking system and an uncompetitive segmented market structure (Zaim, 1995). Isik and Hassan (2003) elaborate that the increase in number of branches meant heavy investment in costly human capital and fixed assets which increased the overhead cost and consequently reduced bank’s profitability since customers were scarce or few.

Nas and Odekon (1988) argued that another reason for the Turkish banking sector’s inefficiency was the multiplicity of government goals. The focus on regional development and political appointment to meet religious and tribal demands augmented the banks cost. On the contrary, the private sector has only one goal which is to maximize shareholder value and consequently would improve efficiency. Tas and Kar (2002) described the government policies as interventionist and protectionist and classified these polices as follows;

- Minimizing the foreign competition through quotas, high tariffs and licensing requirements to encourage the domestic industrial sector.
- Financing the large fiscal deficit through high level of monetary expansion.
- Controlling interest rates and directing credit to influence the sectoral composition of investment within the private sector.
Adopting a fixed exchange-rate policy and control of the flow of capital which resulted in an overvalued domestic currency.

3.3.3. Financial Liberalisation 1980 - 1994

Before 1980 Turkish banks could be described as a repressed financial system. The sector was characterised by government control of interest rates, barriers to entry, control of capital flows, high reserve requirements, state-owned bank domination and directed credit policies. All led to a highly segmented market and inefficiency in the banking sector overall and in state owned banks in particular.

In the year 1980 the Turkish government accepted to implement the proposed stabilisation policy of the IMF, World Bank and OECD. This was a declaration of the end of era of inward oriented polices. The new reform policies under the Structured Adjustment Program (SAP) aimed to liberalise trade, pricing, foreign exchange and the financial system. The new outward oriented polices depend on market forces without state intervention. The program had three main aims: First, to reduce inflation rate without affecting output growth. Second, to liberalize imports and exports through exchange rate adjustment in order to abolish the current account deficit. Third, to reduce the role of public sector and free the flows of foreign capital through positive real interest rates (Tas and Kar, 2002).

In other words, the aim was to develop competition and improve efficiency in the financial system in order to fully operate in a more liberal economic environment. The first stage of the reforms was between 1980 and 1983- it started with deregulating the interest rate system by lifting the ceiling on personal time
deposits rate and abolishing restrictions on lending rates. Another form of reform was allowing both resident and non-resident to open foreign deposits accounts. The deregulation of interest rates ignited fierce competition among the banks. This led to a sharp increase in interest rates and ended up with what so called the “banker crises” in 1982. The large banks had to intervene to keep the rate low and reached what was called the “gentleman agreement”. The intervention was unsustainable, that it has eventually collapsed and caused further increase in the interest rates. According to El-Gamal and Inanoglu (2005), the bank crisis in 1982 caused the collapse of six banks during 1983 and 1984. The government had to intervene again to restore financial stability –therefore once again the Central Bank regulated the deposit rate until 1988.

The 1982 crises revealed that financial liberalisation polices were not supported by an adequate regulatory and supervisory framework. Consequently, the government introduced the new banking Law in 1985. The new Law introduced new regulations including the provision of minimum capital and a capital adequacy ratio. The Central Bank of Turkey (CBT) supervision’s unit became functional and foreign banks were allowed to enter the industry in 1986. The number of banks increased to 66 between 1980 and 1999 compared to 43 banks in 1980, 8 banks merged with other institutions and 31 new entries were observed of which 19 were foreign and 11 were domestic banks (Isik and Hassan, 2003).³²

The 1980’s witnessed frequent economic shocks on the Turkish banking sector. These shocks were represented in sharp increase in interest rates, high

³² See Appendix (2) table (1)
speculations on the exchange rate and sharp devaluation of the Turkish Lira (TL). These caused subsequent interventions, by the Central Bank to alleviate the situation by imposing entry barriers and requiring minimum start-up capital. The financial turbulence connected to the liberalisation polices led some banks to exit the industry due to bankruptcies.

The SAP and the liberalisation policies had positive impact on banks. It resulted in: the abolishment of the credit and deposit rate ceilings, unification of accounting principles and the mandatory of external audit, the liberalisation of foreign exchange regime, freeing entrance for foreign banks and the permission for banks to directly borrow abroad. The banks reduced the excessive branches and human resources. More focus given toward acquiring technological infrastructure and highly qualified human capital. Banks also started to provide international banking services and expand overseas via own branches or subsidiaries during the late 1980s and early 1990s (Isik et al., 2002).

The Turkish SAP implemented the liberalisation policies simultaneously. The financial turbulence that followed these polices may have been driven by the lack of gradualism and the high speed of policy implementation. Nevertheless, the reform seemed to successfully achieve its aims and fostered efficiency and productivity of the Turkish banks throughout the 1980s. The reduction of both work force and number of branches had a significant impact on cost reduction and consequently improving the efficiency and productivity of the Turkish banks (Isik and Hassan, 2003) and (Zaim, 1995).
3.3.4. The 1994 crisis

The positive outcome of the financial liberalisation particularly reflected in the improvement of banks’ performance. Nevertheless, the Turkish economy and the financial system in particular seemed fragile. Eventually some internal and external factors negatively affected the economy overall and consequently reduced banks’ performance. The surrounding political environment of Turkey was typified by the collapse of the Soviet Union, conflicts in Balkans and Caucasus and the first Gulf war besides internal political instability. These collectively cast a gloom over the Turkish economy at the time. Unlike the Egyptian case, which benefited from the Gulf war, the war cost Turkey around $6 billion due to the high increase in oil prices.

The global economy also experienced depression. The financial crises in emerging economies and the expansionary fiscal policies adopted by the Turkish government after the late 1980s as well as the imprudent monetary policies of the 1990s all combined to cause the financial crisis of 1994. The government’s expansion of high interest rate, short-term credit to finance the fiscal deficit resulted in an inflation rate of 70% in 1993. All these paved the way to exchange rate crises in 1994.

The Central Bank was forced to increase the interest rate and the TL was devaluated by 60%. The overnight interest rate jumped to 1000% and the sector faced low levels of liquidity due to the prohibitive rate of deposit withdrawal. The

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33 This was caused by four elections and nine consecutive governments in a very short time period.
34 See section (3.2.) for more details on the Gulf war benefits on the Egyptian economy.
financial system was in a chaotic situation and was subject to moral hazard. The government refused to close down the insolvent banks caused by the crises. Instead it offered a full guarantee on deposits\textsuperscript{35} (deposit insurance) to stabilise the market. The new stabilisation programme supported by IMF also included fiscal adjustment and tightening the monetary policy. The programme reversed the worsening currency substitution effect thus, reduced the foreign currency deficit and stabilised the financial market. The programme had initial positive effects on the financial markets. On the other hand it had an appalling effect on the economy, the economy grow at negative rate -6%, inflation was a high level 121% and the foreign reserve was at its lowest levels\textsuperscript{36} (Soral et al. 2006).

Beim and Calomiris (2000) argue that in the case of government guarantee of banks’ liabilities, prudent policies should be put in place to prevent massive losses on the part of government. There were 15 poor financial status banks between 1985 and 1999 (Soral et al. 2006). However, the government was unwilling to close these banks because of the consequences of liquidating them. In effect, the banks were deteriorating because they were conscious that the government was considering to liquidate them. In addition, during mid 1990s banks became dependent on the government borrowing, as it was difficult for the government to raise funds on the international debt market. The government turned to private commercial banks which in turns borrowed the money abroad and were content to pass it through to the government to enjoy the high yield\textsuperscript{37} on treasury bonds or bills (Damar, 2004).

\textsuperscript{35} A full guarantee to all savings was introduced until May 2000.
\textsuperscript{36} See Appendix (2) table (2)
\textsuperscript{37} Interest rate reaches 143%.
As response to the financial turbulence, the banks performance deteriorated during the late 1990s. Despite the efficiency gains in the banking industry after the liberalisation policies in early 1980s, there were no significant improvement in efficiency in the late 1990s in spite of the government efforts to stabilise the financial sector after the 1994 crisis (Ozkan-Gunay and Tektas, 2006), (Yildirim, 2002), (Isik and Hassan, 2002) and (Zaim, 1995).

3.3.5. The Period between 1999 and 2001 (Period of two Crises)

The government launched another reform program - the Disinflation Program which was also supported by the IMF. The aim of the program was to reduce inflation through the implementation of consistent and credible fiscal and monetary policies, to establish a stable financial sector and to strengthen banks’ financial structure. The program had three dimensions of reform: first, launching the new Banking Law; second, establishing complementary regulations; third privatising the state owned banks. New regulations in capital adequacy and risk management were introduced and the Saving Deposit Insurance Fund (SDIF) absorbed the banks in receivership at the end of 1999.38

The program was successful in the early stages in terms of improving the fiscal situation and reducing interest rates (Akyuz and Boratav, 2003). Nevertheless, the inflation rate could not be reduced at the same pace and accordingly affected the reliability of the program. Therefore, the banks had difficulties in borrowing from

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38 See Appendix (2) table (3)
abroad because of the unreliable economy and the unstable banking conditions. The government established a new regulatory body, the Board of Bank Regulation and Supervision (BRSA) in September 2000. The aim of BRSA was to commence the supervision and monitoring of banks through prudent regulations regarding capital requirement, foreign exchange positions and other issues related to bank performance. However, the delay in the privatisation program and structural reform, high public deficit and deteriorating current account deficit put pressure on economy.

In addition, the IMF postponed the release of credit in October 2000. As a result, foreign investors lost confidence in the government and a speculative sell-offs wave of the TL caused financial panic represented in huge capital outflow, low levels of liquidity in the banking sector and interest rate soared to 100%. The BRSA attempt to contain the disrupted financial sector was not successful. Surprisingly the BRSA adopted a prospective approach towards bank’s managers and major shareholders instead of intervene prudently to rehabilitate the situation in the banking system. The result was the November 2000 crisis triggered by the aforementioned events.

3.3.6. After the 2001 Crisis

The Turkish banking sector continued to suffer from the effects of the two consecutive crises –the first one was in November, 2000 and the second one was
in February, 2001. In July 2001 the collapse of five private depository institutions and two investment banks was a clear evidence of the fragile banking sector and financial structure. The failed banks were transferred to SDIF (Saving and Deposit Insurance Fund). This made the number of banks absorbed by SDIF within the period 1997-2002 to reach 20 banks. Some of these banks were sold and others were liquidated. In addition to these cases, some vulnerable state banks merged in order to eliminate excess branches and employees. As a result, the crisis caused considerable amount of cost. According to Damar (2004:16):

“A total of 20 banks were closed, either through liquidations or mergers. Almost 36,000 banks employees were laid off (out of 174,000) and the initial losses of the failed banks were estimated at $6.2 billion. Between December 1999 and April 2003, the SDIF spent another $21.4 billion in an attempt to recapitalize these banks. Those that were sold had to be liquidated.”

3.4. A comparison of Egypt and Turkey

Egypt and Turkey have interesting experience in terms of the evolution of both economies and consequently of their financial systems. Both countries had long
historical relationship since Egypt was under the rule of the Ottoman Empire, which was based in Istanbul (Constantinople) at the time. Up till now both countries have common many legacies since the Ottoman Empire days. 

Turkey had its independence in 1923 and started to reform the financial sector while Egypt in the 1920s was still under British colonisation. Unlike Turkey the ownership structure of the Egyptian banks at the time was dominant by foreign banks.

The reforms implemented by the Turkish government in the early 1930s aimed to increase the private sector’s role in the economy. However, the country was directing its focus toward heavy industrialisation and the private banks could not provide sufficient funds to support such mega projects. The Turkish government expansion in state-owned banks and specialised banks tightened the market opportunities for private sector banks. The private banks could not compete with the large state-owned banks supported by the government and had no choice but to exit the industry.

Unlike Turkey, the Egyptian banking sector in 1930s was devoting most of its finance resources towards agricultural projects (i.e. cotton plantations). Consequently the sector suffered from a crisis in 1939 caused by the huge drop in cotton prices world wide. Since 1930s till 1960s, the state-owned banks dominated the banking sector in Turkey. With interventionist and protectionist behaviour, the government repressed the financial system by focusing on state resources.

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39 See Appendix (3) table (1)
banks, entry barriers and directing credit. Consequently Turkish banks were over-staffed and had excessive branches.

Egypt gained its independence in 1952 and the government adopted socialist values, which led to the implementation of nationalisation policies. This wave ended with the nationalisation of all the banks. Consequently the sector became state-owned by 1965. Similar to the Turkish experience the banking sector suffered from government intervention, directed credit, over-staffing and excessive branches problems.

Turkey’s first attempt to impose reform policies and liberalise the financial system was in the 1960s. However, it experienced subsequent financial crises and the government was forced to intervene to stabilise the system. The banking sector continued under repressive policies. In contrast, the first attempt to liberalise the Egyptian financial sector lagged the Turkish experience by 15 years. The open-door “Infitah” policy in 1975 encouraged foreign investment and private sector to enter the industry after fifteen years of repressive and strict barrier to entry policies.

The liberalisation attempts in both countries failed to achieve their objectives. The banking sectors in both countries remained financially repressed. However, Turkey suffered from financial crises at the beginning of the liberalisation program. Egypt in contrast had a stable financial sector.

Turkey embarked on its comprehensive economic reform program in 1980 (The Structured Adjustment Program) SAP. On the other hand, The Egyptian financial
liberalisation lagged the Turkish experience by 10 year through the introduction of the Economic Reform and Structural Adjustment program (ERSAP). The IMF and the World Bank proposed the economic reform programmes in both countries. The reform programmes managed to improve bank performance in each country. However, unlike Turkey, Egypt did not experience serious financial problems or any sort of financial crisis post liberalisation.

The reason for the stability of the Egyptian financial system owed to the cautious approach adopted by the government in implementing liberalisation policies. This contrasts with the Turkish case that suffered from several financial crises in the 1980’s and 1990s due to lack of gradualism in implementing liberalisation plans. The other reasons could be that, the Egyptian financial system was managed under a strong system and tight regulations. In contrast, the Turkish financial system lacked the control and prudent regulations at that time. Thus, Turkey experienced financial crises in 1991, as the banking system was not prepared to abide to the expansion policies.

**3.5. Conclusion**

Both Egypt and Turkey passed through the same experience in the evolution of their banking systems. Both countries’ banking sectors experienced waves of nationalisation in the past. Turkey’s economic reform and financial liberalisation
started in 1980 - ten years earlier than Egypt. The IMF and World Bank proposed reform policies in both countries. The aim of SAP and ERSAP in Turkey and Egypt respectively had almost identical objectives. In general the reform programmes aimed to promote competition improve efficiency and abolish financial repression behaviour. Despite the success of liberalisation policies in both countries, the Turkish financial system suffered from several crisis shocks, which affected the sustainability of efficiency growth in most of the banks. Dissimilar to the Turkish case, Egypt financial system did not suffer from any post liberalisation financial crisis.

The two countries have adopted two contrasting approaches in implementing financial liberalisation policies. Egyptian policy makers were vigilant and adopted gradual approach. In contrast, Turkey has implemented the liberalisation policies impetuously, and without gradualism. Both governments need more prudent measures in the banking sectors to stabilise and strengthen the banks in the industry. Issues like, corporate governance, capital adequacy and under-capitalisation, privatising state-owned banks need attention by the monitoring authorities in both countries.
4. Chapter four: Methodology

4.1. Introduction

One of the principal objectives of implementing financial liberalisation programmes is to improve the efficiency of the banking industry (Berger et al., 1997). The competitive environment and the flexibility of more liberal regulations (i.e. deregulations) presume to provide banks more freedom and control over the utilisation of their resource.

This thesis adopts the frontier approach to measure the efficiency and productivity of two emerging economies banking systems namely Egypt and Turkey during periods characterised by changes in regulations and economic policies in both countries. The frontier methods can be generally classified as parametric and non-parametric methods of which both of these methods are employed in this thesis. The non-parametric approach is the linear programming deterministic method, the DEA. The parametric econometric method is the SFA. There is no agreement in the literature so far on which method is preferred to detect the best-practice frontier (Berger and Humphrey, 1997).

The frontier methods are widely used in analysing the impact of regulatory policies (liberalisation, deregulation, privatisation and financial disruption), merger acquisition, and foreign ownership entrance on the performance of the firms (Bauer et al., 1998). Berger and Humphrey (1997) find frontier methods superior in measuring firm’s performance compared to the non-frontier methods
(i.e. financial ratios) in particular for regulatory purposes. Hence, they argue that frontier methods provide more accurate measures of firms and managerial performance.

This chapter introduces the two methodologies employed in analysing the data. The efficiency scores are estimated using both the non-parametric DEA (Banker, Charnes and Cooper, 1984) and the parametric SFA [(Battese and Coelli, 1992), (Battese and Coelli, 1995), and (Coelli, Perelman and Romano, 1999)]. The productivity measures are estimated by employing the DEA-based Malmquist Total Factor Productivity Index (MTFPI) (Färe, Grosskopf, Norris and Zhang, 1994). The Generalised Malmquist Productivity Index (GMTFPI) is used to estimate the parametric productivity measures. (Orea, 2002)

Charnes, Cooper, and Sueyoshi (1998) and Learmer (1994) emphasise that using different approaches to investigate the economic phenomenon is an appraisable procedure to crosscheck the robustness of the results obtained from alternative methods, in particular when firms operate in diverse and extreme conditions (i.e. regulatory changes). This thesis also uses two methodologies. In the literature, few banking studies simultaneously applied two methods [see among others, Resti (1997), Bauer et al. (1998), Casu et al. (2004) and Becalli et al. (2006)].

The chapter is organised as follows. The first section presents a review of Farrell’s efficiency measurement as both of the methodologies (DEA and SFA) used in this thesis are originated from Farrell’s (1957) seminal work. The second section discusses the nonparametric DEA method and technical efficiency
estimation. The third section introduces the non-parametric estimation of Malmquist productivity index. The fourth section provides the parametric technical efficiency measurement technique, SFA. The fifth section discusses the parametric Malmquist productivity index and its components. Section six presents the variables and the data. The conclusion follows in the final section.

**4.2. Farrell’s Efficiency Measures**

Debreu (1951) and Koopmans (1951) highlighted the frontier nature of a production function in economics. Debreu (1951) suggests the “coefficient of resource utilisation” as the first measure of technical efficiency. Debreu’s measure ‘represents the smallest proportion of resources required to produce certain output level. Koopmans (1951:60) provides a formal definition of technical efficiency: “a producer is technically efficient if an increase in any output requires a reduction in at least one other output, or an increase in at least one input, and if a reduction in any input requires an increase in at least one other input or a reduction in at least one output”.

Nevertheless, Farrell’s (1957) seminal work is considered to be the first to provide an empirical treatment of the production function as ‘frontier’. Farrell’s study achieved the decomposition of the overall (productive) efficiency into the two currently widely known components: the *allocative efficiency* and the *technical efficiency*. The allocative efficiency represents the aptitude of a firm to use the inputs in optimal proportions, given the respective price and the production technology. The technical efficiency reflects the ability of a firm to obtain maximal
output from a given set of inputs. The ‘Farrell efficiency measure’ calculates efficiency as a relative distance to the production frontier. Thereupon, both technical and allocative efficiency measures are defined as the ratio of potential and actual performance. Figure 4.1 illustrates the concept of efficiency measure. Consider a firm or organisation producing only one output $Y$ from two inputs $X_1$ and $X_2$. The curve $QQ$ (isoquant) represents combinations of the inputs $X_1$ and $X_2$ to produce a certain level of output. The cost minimising plane (isocost) is represented by the line $CC$. The $CC$ line also represents the ratio of factor prices. Firm $B$ is inefficient since it utilises more inputs to produce unit output.

![Figure 4.1 Farrell’s Input Efficiency Measures](image)

The technical efficiency of $B$ is $OQ'/OB$, this measures the radial distance that $B$ has from the isoquant. In other words, the ratio of potential to actual input utilisation. Alternatively, the radial distance $OP/OQ'$ from the isocost represents the allocative efficiency. In both technical and allocative efficiency, a value less than unity represents inefficiency. The overall or Pareto efficiency is achieved as the product of price and technical efficiency ratios:

$$OP/OB = OQ'/OB \times OP/OQ'$$
There are two underlying assumptions to Farrell’s efficiency measure. These are constant returns to scale and strong disposability of inputs. The second implies that increased utilisation of an input cannot reduce output, keeping others constant. The assumption of constant returns to scale holds if the production frontier in Figure 4.1 is characterised by unit isoquant, [i.e. \( 1 = f(x1/y, x2/y) \)]. Technical and allocative efficiencies are achieved simultaneously at point R implying full efficiency.

The technical inefficiency of B is measured as \((1-OQ'/OB)\), which indicates the proportion of inputs that could be reduced without any reduction in outputs. The more firm B is getting far from the frontier, the more the performance of B is deteriorating and consequently the technical efficiency ratio declines toward zero. Alternatively, moving closer to the frontier depicts the improvement of firm’s B efficiency. In this case, the efficiency ratio is closer to unity. In general the technical efficiency ratio is \([0 \leq \text{Technical efficiency} \leq 1]\).

Farrell emphasises on the relative nature of the frontier by suggesting the notion of the ‘best results observed in practise’. Farrell’s (1957) pioneering work has inspired the development of two methodological approaches to the construction of production frontiers: the parametric stochastic and the nonparametric or linear programming approaches.

Inspired by Farrell’s work, Shephard (1970) and Afriat (1972) are the earliest studies to suggest a mathematical programming approach to frontier estimation. Charnes, Cooper and Rhodes (1978) (henceforth CCR model) extend the former
authors’ works and introduce the linear programming techniques widely known as the DEA.

The SFA is an alternative econometric method for frontier measurement, which assumes a given functional form for the relationship between inputs and outputs. The influential theoretical studies by Koopmans (1951), Debreu (1951) and Shephard (1953) are considered as the spark that ignited the development of Stochastic Frontier Analysis (Kumbhakar and Lovell, 2000). Farell’s (1957) work was utilised by Aigner and Chu (1968), Seitz (1971), Timmer (1971), Afriat (1972) and Richmond (1974). These scholars contributed to the literature by estimating a deterministic production frontier, either by using linear programming techniques or modifying the least squares techniques. However, the actual origins of SFA can be traced to two papers virtually simultaneously published by two different teams of scholars in two different parts of the world, namely; Meuseen and Broeck (June, 1977) and Aigner, Lovell and Schmidt (July, 1977). Shortly after these, a third SFA paper was published by Battese and Cora (1977).

This thesis focuses on measuring the technical efficiency of the banks by exploiting distance functions. Hence it does not require information on input prices. The reason is that in both data sets, namely Egyptian and Turkish banks, the price information is not available. Two frontier methods are employed in this

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40 Koopmans defined the technical efficiency as: “a producer is technically efficient if, and only if, it is impossible to produce more of any output without producing less of some other output or using more of some inputs”.
41 Debreu and Shephard introduced distance functions to model multiple-output technology.
42 Afriat notified the derived efficiencies which have maximum likelihood.
43 Requires all the residuals to be non-positive.
thesis to estimate the technical efficiency. These are the non-parametric linear programming, DEA and the parametric SFA.

4.3. Why Frontier Methods?

In general research choice is made between two methods to measure and analyse banks performance – these are frontier and non-frontier (i.e. financial ratios) methods. The frontier methods, two of which are employed in this thesis, can be broadly classified as parametric and non-parametric methods. These methods encompass different assumptions on the functional form of the best practice frontier. As mentioned earlier, the literature did not reach consensus on which method is preferred to detect the best-practice frontier.

The widely used non-parametric approaches are known as the DEA and the Free Disposable Hull (DFH) - both are linear programming deterministic methods. The stochastic econometric methods widely used are the SFA, the Distribution Free Approach (DFA) and the Thick Frontier Approach (TFA). This thesis focuses on two of these approaches namely, SFA and DEA.

Berger and Humphrey (1997) argue that compared to non-frontier methods (financial ratios) the frontier approaches are superior for regulatory purpose. Hence, they use programming or econometric techniques to eradicate the effects of exogenous market factors on inputs and inputs prices. Consequently, these methods provide more reliable estimates of the firm’s performance. The authors elaborate that the frontier provides informative results which can be used to: I)
enlighten government officials and policy makers with the impact of liberalisation, deregulation, privatisation, merger and acquisition and market structure on the performance financial institutions. II) It is a useful tool to describe the efficiency of particular industry and ranks the firms within this industry. III) It provides a useful tool in cross checking the similarities or discrepancies might emerge from employing different frontier approaches (i.e. parametric and non-parametric). IV) It identify the best practices and worst practices hence, assist in improving managerial performance by encouraging under performing firms to boost their efficiency to catch-up with the best practice ones [see Berger and Humphrey (1997) for more detailed discussion].

The frontier methods provide convenient tool to measure the performance in the governmental departments and the not-for-profit organisation where profitability is not objective measure of performance efficiency (Norman and Stoker, 1991). The frontier methods considers the effect of environmental variables on the estimated inefficiency which provides more insight for the management and policy makers on the determinants of inefficiency in a firm or industry (Coelli et al, 2005) and (Kumbhakar and Lovell, 2002).
There are three reasons, which motivated the use of two different methodologies in this thesis. First, in the last two decades the efficiency and productivity research introduced an exhaustive investigation to favour one approach over the other. Nonetheless, so far in this vein the literature did not reach a consensus on which method should be preferred (Bauer et al. 1998).

Second, according to Charnes, Cooper, and Sueyoshi (1988), Learner and Leonard (1983), and Learner (1994) an environment with diverse or extreme conditions resembles the beneficial milieu for evaluating models. Hence, using different approaches to investigate the economic phenomenon is an appraisable procedure to crosscheck the robustness of the results obtained from alternative models.

Third, the appropriateness of a given approach depends on the distribution of the data set. Providing that the true level of an institution’s efficiency is often unknown thus, using both techniques diminishing the potential bias that might exist due to the distributional assumption of the data set (Berger and Humphrey, 1997).

The applied methods in this thesis - the DEA and SFA each has its advantages and disadvantages. DEA is a linear programming deterministic method that does not account for random errors. Thus, it does not require assumption for the underlying distribution about the error term. In contrast, SFA is a stochastic
method, which requires functional form and incorporates random errors. The output of a firm is a function of a set of inputs, inefficiency and random error\textsuperscript{44}, and requires assumption for the error term distribution. The DEA does not count for statistical noise, consequently the efficiency estimates may be biased if the production process is largely characterised by stochastic elements (Coelli et al., 2005).

The deterministic nature of the DEA assumes that all the deviations from the efficiency frontier are under the control of the firm (Bank). However, there are some circumstances such as regulations, competition, etc. which is out of the firm’s control and affect the performance of the firm. On the contrary, the SFA procedures allow modelling these factors by introducing the double-sided random error into the specification of the frontier model (Murillo-Zamorano, 2004).

The DEA method does not allow for statistical significance test. In contrast the SFA allows for such test. The likelihood ratio test (LR) can be used to decide on the model true specification among alternative models (Battese and Coelli, 1995). However, using of Maximum Likelihood techniques in SFA does not allow for the assessment of inference reliability in small samples.

\textsuperscript{44} In the case of production function, multiple outputs and multiple inputs can be estimated by exploiting the distance functions flexibility.
Table 4-1 Comparison between SFA and DEA

<table>
<thead>
<tr>
<th>Conditions</th>
<th>SFA</th>
<th>DEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior assumptions on production frontier needed</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Accommodates multiple inputs and outputs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Accounts for error terms</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Prior assumptions for the error term</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Allows for environmental variables</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Allows for hypothesis test</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Allows for variables inclusion test</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Allows for distributional assumptions test</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Multicollinearity problems</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Provides information on peers</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Vulnerability to small number of observations</td>
<td>Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Vulnerability to endogeneity bias</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Allows for endogeneity bias test</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Nonetheless, the estimation of technical efficiency for multiple input and output producers is permissible using a simple production frontier by exploiting the distance function approach (Kumbhakar and Lovell, 2000). Chapter seven in this thesis aims to compare between the DEA and SFA estimated efficiency scores from the two empirical chapters (five and six) following the consistency conditions proposed by Bauer et al. (1998).
4.5. Non-parametric Methods: Data Envelopment Analysis (DEA)

4.5.1. Technical Efficiency (DEA)

Farrell’s (1957) proposition of frontier estimation as a piece-wise-linear convex hull has inspired Boles (1966), Shephard (1970) and Afriat (1972). These authors suggest mathematical programming methods to achieve the task of measuring firms’ efficiency. However, the introduction of the DEA technique by Charnes, Cooper and Rhodes (1978) (CCR) induced wide attention to the non-parametric methods. The authors proposed an input orientated approach to measuring efficiency assuming constant returns to scale (CRS). Subsequently, Fare, Grosskopf and Logan (1983) and Banker, Charnes and Cooper (BCC) (1984) propose the variable returns to scale (VRS) version.

DEA is a non-parametric linear programming technique used to develop empirical production frontiers and to evaluate the performance of firms, or Decision Making Units (DMUs). These DMUs are assumed to be homogenous and consistently perform the same function by utilising multiple inputs to produce multiple outputs. According to CCR description, DEA is a mathematical programming model that provides a new way for estimating extremal relations from observational data. One principal feature of the DEA method is its ability to manage multiple inputs and outputs.
For instance, when a DMU utilises one input to produce one output, the efficiency is simply measured as:

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

Generally, firms or DMUs tend to produce more than one output by using one or more inputs. The equation above can be generalised to accommodate for the multiple inputs and outputs characteristic of the DMU by reducing these inputs to a single input and output. This is achieved by the weighted average of inputs and a weighted average of outputs:

$$\text{Efficiency} = \frac{\text{Weighted sum of outputs}}{\text{Weighted sum of inputs}}$$

Consequently, a common set of weights is assumed for each DMU. Such assumption is very difficult to presume in practice hence it implies that all the DMUs under study assign similar importance to the same inputs and outputs. CCR, (1978) overcome this problem by allowing each DMU to adopt its own set of weights. Hence, maximize its best possible efficiency compared to the other DMUs. In this condition, the efficiency for a DMU is determined as a maximum ratio of weighted outputs to weighted inputs. The ratio form for CCR (input based) model is as follows:
4.5.2. The CCR Model

\[
\begin{align*}
\max \quad & \varphi_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \\
\text{subject to} \quad & \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \quad (4.1) \\
\end{align*}
\]

\[
\begin{align*}
\text{where:} \quad & u_r, v_i \geq 0 \text{ and } r = 1, \ldots, s; \quad i = 1, \ldots, m \text{ and } j = 1, \ldots, n
\end{align*}
\]

Where:

\(j\): a specific DMU (Bank) to be evaluated

\(y_{rj}\): the amount of output \(r\) from DMU \(j\)

\(x_{ij}\): the amount of input \(i\) to DMU \(j\)

\(u_r\): weight chosen for output \(r\)

\(v_i\): weight chosen for input \(i\)

\(n\): number of DMUs

\(s\): the number of outputs

\(m\): the number of inputs

The function defined by \(\varphi_j\) aims to maximise the ratio of weighted outputs to weighted inputs of the DMU under inspection. This is subject to the constraint that any other DMU in the sample cannot exceed unit efficiency by using the same weights. It is worth noting that these weights are assumed to be unknown, however they are obtained through an optimisation process, performed independently for each unit to compute both the weights and the efficiency measure \(\varphi_j\).
The optimal values of the weights $v_i^*$ and $u_j^*$ have a shadow price interpretation. The weights indicate the relative importance of each input and output respectively in determining the efficiency score of the DMU. This procedure makes it possible to compute both marginal rates of substitution between inputs and marginal rates of transformation between outputs.$^{45}$

The efficiency score obtained by the problem setting (4.1) is consistent with Farrell’s interpretation. A DMU is efficient if the efficiency score is equal to one, and it is said that the DMU performs at ‘the best practice’. The contrary obtains if the efficiency score is less than one, the DMU is considered as inefficient. The subset of efficient DMUs represents the ‘reference set’ for the inefficient ones. Hence, the efficiency measure ranges from zero to one.

The problem setting in equation (4.1) is a fractional program. This problem can be converted into linear program (LP) form by restricting the denominator of the function $\phi_j$ to unity (i.e. $\sum_{i=1}^{m} v_i x_{ij} = 1$), and adding this as a constraint to the problem.

The form of DEA model in Linear Programming (LP) is known as the multiplier form.

---

$^{45}$ The marginal rate of substitution is the rate at which an input is decreased while another input consumption is increased, but the level of outputs produced is still the same. Likewise, marginal rate of transformation is the rate at which one output is reduced while another output is increased, but the amount of inputs consumed stay unchanged.
4.5.2.1. Primal

\[
\max \varphi_j = \sum_{i=1}^{s} u_{ij} y_{ij}
\]

subject to \( \sum_{i=1}^{s} v_{ij} x_{ij} = 1 \)

\[
\sum_{i=1}^{s} u_{ij} y_{ij} - \sum_{i=1}^{m} v_{ij} x_{ij} \leq 0
\]

\( u_{ij}, v_{ij} \geq 0 \) and \( r = 1, \ldots, s \), \( i = 1, \ldots, m \), \( j = 1, \ldots, n \)

The linear programming problem in (4.2) assumes constant returns to scale technologies. In the above formulation, the procedure of constraining the weighted sum of the inputs to unity whilst maximising the outputs is called the input-orientated measure of efficiency. Alternatively the output-orientated measure of efficiency is achieved by constraining the sum of the outputs weights to unity and solve for minimising the inputs.

4.5.2.2. Dual

Another possible solution to the primal linear programming (LP) is to develop a dual formulation for (4.2). This can be achieved by denoting the input weights of DMU B by \( \theta_j \) and the input and output weights of other DMUs in the sample by \( \lambda_j \), the dual form of the maximising problem is formalised as follows:

\[
\min \varphi_j = \theta_j
\]

subject to \( \sum_{j=1}^{n} \lambda_j y_{ij} - s_i = y_{ij} \)

\( \sum_{j=1}^{n} \lambda_j x_{ij} + s_i = \theta_j x_{ij} \) \hspace{1cm} (4.3)

Where \( \lambda_j, s_i, s_i^\ast \geq 0 \) and \( j = 1, \ldots, n \).
The solution to primal and dual provides the same information. However, calculating the dual is computationally faster. Hence, the number of constraints in the dual is less than the constraints in the primal. There are $n+s+m+1$ constraints in the primal model in contrast the dual has only $s+m$ constraints. It is worth noting that the dual formulation does not encompass the shadow price interpretation of the variables as in the primal form. This is because the dual concerned with the weights $\lambda_j$ on DMUs rather than on inputs and outputs. The dual weights $\lambda_j$ are non-negative.

There are two constraints to be considered in the computation of the efficient use of inputs for DMU B in (4.3). First, the reference DMUs should produce as much output as DMU B, (i.e. $\mathbf{y} = \sum_{j=1}^{s} \lambda_j \mathbf{y}_j$). Second, the weighted inputs corrected by the efficiency of the DMU B should be at least equal to the amounts utilised by the reference DMUs, (i.e. $\mathbf{x} \geq \sum_{j=1}^{s} \lambda_j x_j$). The aim is to minimise this correction fraction, $\theta$. Hence, the amount by which the inputs DMU B should contract in order to be fully efficient is determined by $\theta$. These constraints in fact represent the envelopment principle hence, the name of DEA. The first constraint ‘envelops’ the outputs of DMU B from above. The inputs of DMU B are enveloped from below via the second constraint. The DMU B is efficient if $\theta$ is equal to unity and the slacks ($S_j^-$ and $S_j^+$) are zero. In contrast, DMU B is inefficient if $\theta < 1$ and/or positive slacks exist.
The CRS assumption in the previous model suggests that all firms are operating at an optimal scale. Such assumption is likely to be invalid if the firms under scrutiny operate in imperfect competition environment, or in regulated industry, or are subject to financial constraints. These factors independently or collectively might force the firms not to operate at its optimal scale.

Fare et al (1983) suggest the importance of adjusting the CRS and DEA model to count for variable return to scale (VRS). Banker, Charnes and Cooper (1984) (BCC) argue that not all firms are operating at optimal scale. Hence, the use of CRS model in such situation would result in biased measures of technical efficiencies that are confounded by scale efficiency.

Banker, Charnes and Cooper (1984) developed the VRS model by considering the existence of variable returns to scale in the production and measures the pure technical efficiency. BCC (1984) impose the VRS to the formulation in (4.3) by adding extra constraint:

$$\sum_{j=1}^{n} \lambda_j = 1$$

(4.4)

By imposing this constraint, the efficient frontier becomes a convex hyperplane. This is only achieved if $\sum_{j=1}^{n} \lambda_j = 1$, alternatively if $\sum_{j=1}^{n} \lambda_j \neq 1$ then;

$$\sum_{j=1}^{n} \lambda_j < 1 : \text{Imply increasing returns to scale (IRS);}$$

and

$$\sum_{j=1}^{n} \lambda_j > 1 : \text{Imply decreasing returns to scale (DRS).}$$
If the convexity constraint is dropped, the frontier technology changes from VRS to CRS technologies. The scale efficiency can be achieved by dividing the CRS efficiency scores by the VRS efficiency scores of (i.e. \( \frac{\theta_{\text{CRS}}}{\theta_{\text{VRS}}} \)).

The DEA model does not require a functional form thus it constructs the frontier from the observed input-output ratio using linear programming techniques however, the drawback of the model is that it does not account for stochastic shocks. In other words it is deterministic. Unlike parametric techniques, DEA does not accommodate random noise which make its efficiency scores questionable i.e. biased by factors that are exogenous to the production process. Many studies attempted overcoming this drawback. Varian (1985) calculates efficiency score, free of random noise by introducing the two-sided deviation. Land et al (1993) introduce the chance-constrained efficiency by allowing random noise to the deterministic frontier without being stochastic.

In an attempt to provide a statistical foundation for DEA, Simar and Wilson (2002) employ bootstrapping techniques by involving thousands of randomly selected “pseudo samples”\(^{46}\) from the observed set of sample data. Although the authors provided Monte Carlo evidence that their method would be effective in case of one-input one-output, they have noted that the method “lacked a rigorous proof or consistency”

\(^{46}\) Using simple random sampling with replacement.
4.5.3. Nonparametric Productivity Measurement: DEA-based Malmquist Productivity Index

In addition to measure the efficiency of two emerging economies’ banking sectors, this thesis also measures the impact of liberalization policies on the productivity growth of these banking sectors. Moreover, it decomposes productivity growth into its components, namely efficiency, technical and scale change. This aims to explain and characterize the differences and similarities in the banking sector growth of the previously mentioned countries.

A total factor productivity (TFP) index that incorporates multiple inputs and outputs into a single productivity ratio would be ideal to achieve these research aims. There are three alternative productivity indexes, the Partial Factor Productivity (PFP)\textsuperscript{47} index, the Tornqvist index, and the Malmquist\textsuperscript{48} index. The last two TFP indexes are considered superior to the PFP indices because they provide a consistent productivity comparison between the DMUs inputs and outputs (Kuussaari, 1993).

The collected data does not incorporate inputs and outputs prices. Thus, the Malmquist productivity index is considered as the prime choice because it does not require any price information or any behavioural assumption such as cost minimization, profit maximization and revenue maximization.

\textsuperscript{47} PFP measures some aspects of productivity by taking into account particular factor of production (i.e. cost/labor) and thus fail to recognise multi-output nature of DMUs

\textsuperscript{48} Tornqvist index requires price data, Malmquist index is quantity index
The origin of the Malmquist index was in Malmquist (1953) who developed an index in the context of consumer theory to measure the quantity of consumption that an individual needed to consume in a certain year, and to achieve the same utility level as in the previous year. Malmquist (1953) proposed the construction of input quantity indexes as ratios of distance functions. Caves, Christensen and Diewert (CCD) (1982) introduced the Malmquist index to identify productivity growth between two time periods. A change in total productivity occurs either by a change in relative technical efficiency of a DMU or by a change in technology.

CCD (1982) developed the idea of using distance functions in productivity analyses. The authors utilised the distance function concept of Shephard (1953) and introduced the Malmquist index in the framework of a general production function as a productivity index. They distinguished between input based and output based productivity indices. However; they did not recognise that these indexes corresponded to input saving and output increasing Farrell measures of efficiency.

Färe, Grosskopf, Lindgren and Roos (FGLR) (1992) realized the direct link between the distance functions concept and Farrell’s (1957) measures of technical efficiency. They found that the distance functions were reciprocal to Farrell measures of technical efficiency. FGLR (1992) used input orientated approach to calculate the Malmquist productivity index for Swedish pharmacies. Färe Grosskopf, Norris and Zhang (1994) (FGNZ) used output-orientated approach Malmquist index to measure productivity growth in OECD countries. DEA Malmquist index is decomposed into two components, the technical efficiency changes (catching up) and the shifts in frontier technology or technological changes over time (innovation) (FGLR, 1992).
The decomposition of the index into two components provides more insight into the sources of productivity change. Moreover, the index requires no assumption on the economic behaviour of production units. In addition, it does not require knowledge of inputs prices.

DEA-based Malmquist productivity index has been increasingly used particularly in panel data applications. Hence, it has helped in examining the effectiveness of certain public policies [see among others Berg et al. (1992) for the deregulation of Norwegian banking, Price and Weyman-Jones (1996) for the privatisation of the UK gas industry, Griffel-Tatje and Lovell (1996, 1997) for the deregulation of Spanish savings banks and Isik and Hassan (2003) for the liberalisation effects on Turkish banks].

Malmquist indexes for panel data sets can be constructed in two ways. First, there is the adjacent method, in which the Malmquist index is computed for each period [i.e. for the first adjacent period (t+1, t)]. Subsequently, another computation for the second adjacent period (t+2, t+1) and this continues to the end of the sample. Second, the Malmquist index can be achieved for all periods but to a relative fixed base period or year. These two approaches generate the same values for the relative technical efficiency change component. However different values are obtained for the technological change component if the production frontiers coincide. Consequently, the Malmquist index generates different values.

This thesis employs the adjacent periods approach to examine the recent productivity performance of the Egyptian and Turkish banking sectors to assess the
results of the liberalisation and reform policies. An input-oriented index is specified, providing outputs with minimum input consumption. To construct an input based productivity index, FGLR (1992) and FGNZ (1994) approaches are followed.

Considering a unit in two periods \( t \) and \( t+1 \), the latter being the most recent period, let \( x^t \in R_+^N \) and \( y^t \in R_+^N \) denote the input and output vectors respectively. Then an input-based Malmquist productivity index for adjacent periods is defined as

\[
M_{i}^{\text{int}}(y^t, x^t, y^{t+1}, x^{t+1}) = \left[ \frac{D_i^t(y^t, x^t)}{D_i^t(y^{t+1}, x^{t+1})} \right]^{\frac{1}{2}} \left[ \frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^{t+1}(y^t, x^t)} \right]^{\frac{1}{2}}
\]

(4.5)

CCD (1982) defined the index in (4.5) as the geometric mean of two Malmquist indexes. Moreover, they assumed that \( D_i^t(y^t, x^t) \) and \( D_i^{t+1}(y^{t+1}, x^{t+1}) \) are equal to 1 for all observations and periods. These assumptions mean that there is no allowance for inefficiency according to Farrell (1957) measures. FGLR (1992) relax these assumptions to allow for inefficiencies and decompose the productivity index into two components: technical efficiency change “catching up” (TEC) and the technological (TC) “frontier shift”

\[
M_{i}^{\text{int}}(y^t, x^t, y^{t+1}, x^{t+1}) = \left[ \frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^{t+1}(y^t, x^t)} \right]^{\frac{1}{2}} \left[ \frac{D_i^t(y^t, x^t)}{D_i^{t+1}(y^{t+1}, x^{t+1})} \right]^{\frac{1}{2}}
\]

(4.6)

where

\[
\text{TEC}_{i}^{\text{int}} = \frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^t(y^t, x^t)}
\]

(4.7)
Accordingly, the Malmquist total factor productivity equals TEC * TC

The Malmquist productivity index indicates productivity progress when the index is more than unity. In contrast, productivity regress is obtained when it is less than unity. In the case of the index is equal to 1, this implies no change in productivity. Similarly, the same concept applies to the components of the index (i.e. TEC and TC). If TEC and TC are greater than unity implies progress in the components, and the regress is associated with values less than unity.

FGNZ (1994) decomposed the Malmquist index into three components that would influence the productivity growth of a DMU. The three sources of productivity growth in the extended model are: Pure Technical Efficiency Change (PTEFC), Technological Change (TC) and Scale Efficiency Change (SEC). The Malmquist productivity index is $M_i = PTEFC \times TC \times SEC$

$$SEC_{i} = \left[ \frac{D_{i}^{f}(y_{i}^{f},x_{i}^{f})}{D_{i}^{f+1}(y_{i}^{f+1},x_{i}^{f+1})} \times \frac{D_{i}^{f+1}(y_{i}^{f+1},x_{i}^{f+1})}{D_{i+1}^{f+1}(y_{i}^{f+1},x_{i}^{f+1})} \right]^{1/2}$$ (4.9)

The proposed decomposition enables to separate and investigate the effects of two types of productivity growth factors; factors under the DMU control (i.e. pure efficiency change) and factors that are not controllable by the DMU (technology and scale efficiency changes) (FGNZ, 1994).

Appendix (4) presents summary in the debates of the FGNZ (1994) Malmquist productivity index.
4.5.4. Model specification for the Non-parametric Methods

4.5.4.1. Efficiency Model

CCR (1978) constant returns to scale input-orientated technical efficiency model:

\[ \min \quad \varphi_\mu = \theta_\mu \]

subject to \[ \sum_{B=1}^{n} \lambda_B y_i^{B} - s_i = y_i^{B} \]

\[ \sum_{B=1}^{n} \lambda_B x_i^{B} + s_i^- = \theta_i x_i^{B} \]  \hspace{1cm} (4.10)

where \( \lambda_B, s_i^-, s_i^+ \geq 0 \) and \( B=1,\ldots,n \).

BCC (1984) impose the VRS on the formulation in (4.3) by adding extra constraint:

\[ \sum_{B=1}^{n} \lambda_B = 1 \]  \hspace{1cm} (4.11)

where:

B: a specific Bank to be evaluated and \( n \) is number of Banks

\( y_i^{B} \): the amount of output \( r \) from Bank \( B \)

\( x_i^{B} \): the amount of input \( i \) for Bank \( B \)

\( \theta_i \): efficiency score for Bank \( B \)

\( S_i^- \) and \( S_i^+ \): negative and positive slacks respectively

Identification of returns to scale:

\[ \sum_{B=1}^{n} \lambda_B < 1 \] : Imply increasing returns to scale (IRS); and

\[ \sum_{B=1}^{n} \lambda_B > 1 \] : Imply decreasing returns to scale (DRS).
4.5.4.2. Productivity Model

Within the DEA framework, if we assume a constant returns to scale model and use the settings in FGLR (1992), we have \( B = 1, 2, \ldots, n \) banks which use \( i = 1, 2, \ldots, m \) inputs \( X_{it}^{B,i} \) at each period \( t = 1, 2, \ldots, T \) to produce \( r = 1, 2, \ldots, s \) outputs \( Y_{rt}^{B,r} \) at each period \( t = 1, 2, \ldots, T \).

To measure the relative productivity of a bank \( B \) between \( t \) and \( t+1 \), we compute the following LP problem stated below:

\[
[D'_i(y'^{B,i},x'^{B,i})] = \min \lambda
\]

subject to \( Y_{rt}^{B,r} \leq \sum_{B=1}^{B} z_{r}^{B,j} Y_{rt}^{B,r} \), \( r = 1, 2, \ldots, s \),

\[
\sum_{B=1}^{B} z_{r}^{B,j} x_{i}^{B,i} \leq \lambda x_{i}^{B,i} \), \( r = 1, 2, \ldots, m \),

\[z^{B,i} \geq 0, B = 1, 2, \ldots, n.\]

The other distance functions needed to construct the Malmquist productivity index, i.e. \( D'_i(y'^{t+1},x'^{t+1}) \), \( D''_i(y'^{t+1},x'^{t+1}) \) and \( D''_i(y'^{B,i},x'^{B,i}) \) are computed in a similar way expressed in (equation 4.12). According to FGNZ (1994) the input-orientated Malmquist total factor productivity index is:

\[
PTEC_{i}^{t+1} = \frac{D''_i(y'^{t+1},x'^{t+1})}{D'_i(y',x')}\]

\[
TC_{i}^{t+1} = \left[ \frac{D''_i(y'^{t+1},x'^{t+1})}{D''_i(y'^{t},x'^{t})} \times \frac{D'_i(y',x')}{D'_i(y'^{t},x'^{t})} \right]^{1/2}
\]

\[
SEC_{i}^{t+1} = \left[ \frac{D''_i(y'^{t},x'^{t})/D'_i(y',x')} {D''_i(y'^{t+1},x'^{t+1})/D'_i(y'^{t+1},x'^{t+1})} \times \frac{D'_i(y',x')}{D'_i(y'^{t+1},x'^{t+1})/D'_i(y'^{t+1},x'^{t+1})} \right]^{1/2}
\]
whereas:

In the above formulae we have added to the equations subscripts V and C to differentiate between variable and constant return to scale. Thus the notations $D_{iv}^{t} (y^{t},x^{t})$ and $D_{iv}^{t+1} (y^{t+1},x^{t+1})$ represent the distance functions of observations $(y^{t},x^{t})$ and $(y^{t+1},x^{t+1})$ respectively. The first ratio calculates the pure technical efficiency and measures if the bank becomes closer to the VRS frontier.

The second ratio calculates the change in CRS technology as the geometric mean of the shift in technology as observed at $(y^{t},x^{t})$ and the shift in technology observed at $(y^{t+1},x^{t+1})$. The third term calculates the change in scale efficiency as the ratio of scale efficiency in two periods. The next section will review the parametric methods for measuring technical efficiency. The parametric Generalised Malmquist productivity index proposed by Orea (2002) is presented later in the parametric productivity measures. The section is organized as follows. An introduction to SFA is followed by the utilisation of distance function and the calculation of the parametric version of the Malmquist Productivity Index.
4.6. Parametric Methods: Stochastic Frontier Analysis (SFA)

In the production context, the main assumption is that the producer aims to maximize the outputs from certain inputs they use. Many econometricians attempt to measure the production, cost, and profit functions assuming that the producers actually operate on these functions apart from the error term\textsuperscript{49}. Majority of these studies use the least square techniques or variants of least square [See Cobb and Douglas (1928), Arrow et al. (1961) and Berndt and Christensen for flexible production functions. Nerlove (1963) exploits the duality theory to estimate cost functions].


The aforementioned studies conclude that not all producers are successfully optimising their production, profits, and revenues or minimizing their cost. In the light of this evidence that at least most of the producers are not efficient, the frontier\textsuperscript{50} method is evolved as a new reformulation of production analysis. In the frontier analysis context, the producers operating on the production, revenue and

\textsuperscript{49} The randomly or symmetrically distributed statistical noise term $\varepsilon$ with zero means.

\textsuperscript{50} A production frontier characterizes the minimum input bundles required to produce various outputs, or the maximum output producible with various input bundles and a given technology.
profit frontier are characterized as technically efficient. Producers operating
beneath the frontier are characterised as technically inefficient. In contrast, the
producers operating on the dual cost frontier are characterized as technically
efficient and producers operating above the frontier characterised as technically
inefficient.

Thus, the symmetrically distributed error terms with zero means are no longer
appropriate in production analysis. The error terms associated with frontier
analysis are composed of two terms as error components\(^{51}\). The traditional noise
cOMPONENT captures the random variation effects of the operating environment.
The second is a new one-sided component represents inefficiency. Hence the
name Stochastic Frontier Analysis (SFA) is. These composed error terms must be
skewed\(^{52}\) and have non-zero means\(^{53}\) [See Kumbhakar and Lovell (2000), Coelli
et al. (2005)].

The origin of the SFA method is moved to the appendix (5). The discussions
presented in appendix (5) focuses on the SFA models for cross-section data. The
following section directly discusses the SFA models for panel data.

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\(^{51}\) This is the same as the traditional least squares-based approach.

\(^{52}\) Skewed negatively in the case of production, revenues and profit frontiers and positively in the
case of cost frontiers.

\(^{53}\) A negative mean is in the case of production, revenues and profit frontiers and a positive mean
is in the case of cost frontiers.

The frontier models employed in this thesis are applied on panel data sets. Unlike cross-sectional data, panel data requires more efficient estimators of the unknown parameters to be obtained as well as more efficient predictors of technical efficiency. Hence, panel data sets usually contain more observations compared to cross-sectional data sets.

Benefits of panel data can be summarised as follows;

It allows for the relaxation of some of the strong distributional assumptions, which are deemed essential to disentangle the separate effects of the two components of the composite error term inefficiency ($U_i$) and noise ($V_i$).

It obtains consistent predictions of technical efficiencies (TE); and

It allows for the investigation of changes in both technical efficiencies and the underlying production technology over time [For more details, see Schmidt and Sickles (1984), Kumbhakar and Lovell (2000), and Coelli et al (2005)].

According to Aigner, Lovell and Schmidt (ALS) (1977), production function for a panel data can be modelled as follows:

\[
\ln y_i = \beta_0 + \sum \beta x_i + \nu_i + u_i
\]  \hspace{1cm} (4.16)

\[
\nu_i \sim iid \ N(0, \sigma^2)
\]  \hspace{1cm} (4.17)

\[
\mu_i \sim iid \ N(0, \sigma^2)
\]  \hspace{1cm} (4.18)
Assumption 4.17 explains that $\nu_i$ is independently and identically distributed (iid) normal random variables with zero means and variance $\sigma_\nu^2$. Assumption 4.18 explains that $\mu_i$ is iid half-normal random variable with scale parameter $\sigma_\mu^2$. The probability density function of each $\mu_i$ is a truncated version of a normal random variable having zero mean and variance $\sigma_\mu^2$. The model is identical to formula (4) in Appendix (5) except for the subscript “t” added to both inputs and outputs to represent time. The parameters in model (4.16) as well as technical efficiency can be estimated in different ways.

Two methodologies have been developed to measure technical efficiency using panel data. The first is based on the traditional panel data estimators (fixed and random and random effects) and the second utilises Maximum Likelihood Estimators (MLE). Schmidt and Sickles (1984) introduce the traditional method of assuming that the technical inefficiency component of the error term ($u_i$) varies over producers. However, the noise term ($v_i$) varies over producers and time. The fixed effect (FE) model uses dummy variables (Least Square with Dummy Variables LSDV) to account for producer effects. Compared with the ML cross sectional model, the FE models provide consistent estimates of producer-specific technical efficiency. The FE model has two main advantages. Firstly, it does not require distributional assumptions for the two error terms. Secondly, it allows ($u_i$)$^{54}$ to be correlated with the regressors or with the ($V_i$).

Despite its simplicity, the FE model estimator has serious drawbacks. First, it not

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$^{54}$ The ($u_i$) considered as producer-specific intercept parameters to be estimated with $\beta_i$'s.
only captures the variations across producers but also captures all other effects that are time invariant (i.e. regulatory environment). Second, it does not allow for testing to what extent the estimated effects are significantly different from each other. Third, time-invariant variables cannot be introduced among the regressors. Finally, the interaction between the parameters tends to be high especially in large panel data sets. Thus, the FE model is least likely used in the empirical analysis.

The Random Effect (RE) model can be estimated by standard two-step Generalised Least Square Method. Unlike the FE model, the RE allows the inefficiency component to be random (time-variant). Similar to FE, the RE model does not require a specific distributional assumption for the efficiency component. However, it strictly requires the effects to be uncorrelated with the other variables in the model. Kumbhakar and Lovell (2000), Sena (2003), and Coelli et al (2005) provide a thorough discussion on these models.

Pitt and Lee (1981) developed the MLE of a stochastic production frontier panel data model with time-invariant technical efficiency. They applied the model to analyse micro data from Indonesian weaving firms for the years 1972, 1973 and 1975. In order to obtain producer-specific estimates of time-invariant technical efficiency, Pitt and Lee (1981) utilised distributional assumptions parallel to those employed in the normal-half normal model based on cross-sectional data. However, they imposed the constraint that the noise component varies through time as well as across producers.
Kumbhakar (1987) and Battese and Coelli (1988) generalised the half normal assumption of $u_i$ and proposed the normal truncated specification to be used on panel data. The general form of panel data production function is presented as:

$$ y_{it} = x_{it} \beta + v_{it} - u_i $$

(4.19)

$y_{it}$: Output vector

$x_{it}$: Input vector

$\beta$: Coefficient of independent variable

$v_{it}$: Random variable error $N(0, \sigma_v^2)$

$u_i$: Truncated variable error

The above production frontier can be estimated using the ML technique. The resulting error component is decomposed into a noise component and a stochastic inefficiency component, which is consequently used to calculate the efficiency scores for each producer or DMU.

The three approaches to estimating production frontier models with panel data discussed previously, Fixed effect (LSDV), Random Effect (GLS) and the Maximum Likelihood (ML) approach have different properties and impose different properties. Thus, they are used in different circumstances. However, in general, the ML is considered more efficient compared to LSDV and GLS hence, it exploits distributional information which the other two do not (Kumbhakar and Lovell, 2000) and (Sena, 2003).
Gong and Sickles (1989) employ a series of Monte Carlo experiments to investigate the superiority of one of these approaches among the others. They find that three approaches generate similar efficiency estimates in terms of both correlation and rank correlation of the estimates. Nevertheless, they prefer the FE model due to its simplicity compared to the other two. However, they point out that the performance of three approaches deteriorates when the underlying technology is more complex.

Gathon and Perelman (1992) use European railway data to compare the three approaches. They find high correlation between the estimates across the three approaches. Bauer et al (1993) apply the three approaches on US banking data and find high correlation between the FE and RE estimates. However, the former two approaches estimates have low correlation with the ML estimates. All the models above share a common drawback as they assume that inefficiency is time-invariant, which is highly prevalent in the cases of long time-series.

Cornwell, Schmidt, and Sickles (1990) and Kumbhakar (1990) developed a stochastic production frontier with time-varying technical efficiency. They applied the model on panel data in which the producer-specific effect is allowed over time in the technical efficiency component. Lee and Schmidt (1993) suggest a different generalisation where a time-varying technical efficiency can be estimated using both fixed effects and random effects models. They defined the inefficiency term as: $\mu_i = \beta(t), \mu_i$ (4.20)
Battese and Coelli (1992) introduce an alternative time-varying efficiency model that employs maximum likelihood techniques to estimate all its parameters. The model consists of 4.33 and 4.34 with the following modification.

\[ \beta(t) = \exp\{-\gamma(t - T)\} \]  

(4.21)

Where \( \gamma \) is additional parameter to be estimated and the function \( \beta(t) \) satisfies the following properties:
\[ \beta(t) \geq 0 \]
\( \beta(t) \) Decreases at a increasing rate if \( \gamma > 0 \) and increases at an increasing rate if \( \gamma < 0 \), or remains constant if \( \gamma = 0 \)

\( \nu_t \): Random variable error N \((0, \delta^2_v)\)

\( u_{it} \): Truncated variable error

The panel data is composed of several observations for each DMU (Bank) for each year. The translog \(^{55}\) (TL) functional form considered more flexible compared to the Cobb-Douglas \(^{56}\) functional form (Coelli et al. 2005).

The restrictions on the stochastic frontier function are made more flexible with an application of a translog (TL) production function. The TL form does not impose assumptions about constant elasticities of production nor elasticities of substitution between inputs. Another merit of using the TL form is that it allows the data to indicate the actual curvature of the function, rather than imposing prior

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\(^{55}\) A second-order flexible form

\(^{56}\) A first-order flexible form
assumptions. It is worth noting that the drawback of using the translog functional form is that it allows for more parameters to be estimated compared to production function.

The time-varying production frontier can be expressed in translog form as

$$\ln y_{it} = \beta_0 + \sum_{n} \beta_n \ln x_{it} + \beta_t t + \frac{1}{2} \sum_{n} \sum_{l} \beta_{nl} \ln x_{it} + \frac{1}{2} \beta_{tt} t^2 + \sum_{n} \beta_n \ln x_{it} + \nu_{it} + v_{it} - u_{it}$$

\(\text{4.22}\)

\(y_{it}\): Output vector

\(x_{it}\): Input vector

\(\beta\): Coefficient of independent variable

\(\nu_{it}\): Random variable error \(N(0, \delta^2)\)

\(u_{it}\): Truncated variable error

\(t\): Time component

In simple terms the TL form can be written as:

$$\ln y_{it} = TL(x_{it}, t) + v_{it} - u_{it}$$

\(\text{4.23}\)

Battese and Coelli (1995) introduce a panel data frontier model, which account for inefficiency effect in \(\mu_{it}\). The non-negative technical efficiency term assumed to have a truncated distribution with different means for each DMU or producer as follow.

$$\mu_{it} = Z_{it} \delta + \omega_{it}$$

\(\text{4.24}\)\(^{57}\)

where: \(Z_{it}\) captures the inefficiency effect of the variables.

\(^{57}\) For more details, see Battese and Coelli (1995).
4.6.2. Distance Functions and Stochastic Frontier Analysis

The use of distance functions facilitates analysing the productivity and efficiency performance of companies or DMUs, in particular those with multiple inputs and multiple outputs where price information is not available and/or a behavioural assumption is not appropriate (i.e. cost minimisation or revenue maximization). This thesis adopts the input orientation in both methodologies, i.e. the parametric and non-parametric approaches. The estimation of the input distance function in a cross sectional analysis using a Cobb-Douglas production function is introduced bellow for more elaboration.

An input distance function for cross sectional data on \( I \) firms with \( M \) outputs and \( N \) inputs takes the form:

\[
d_i^I = d^I (x_{1i}, x_{2i}, \ldots, x_{Ni}, q_{1i}, q_{2i}, \ldots, q_{Mi})
\]  

(4.25)

Where, \( x_{Ni} \) is the \( n \)-th input for firm \( I \); \( q_{Mi} \) is the \( m \)-th output for firm; and \( d_i^I \geq 1 \) is the maximum amount by which the input vector can be radially contracted without changing the output vector. \( d^I(.) \) is linearly homogeneous, concave and non-decreasing in inputs, and quasi-concave and non-increasing in outputs.

The Cobb-Douglas functional form used to estimate the input distance function in (4.25) is.
\[
\ln d_i^I = \beta_0 + \sum_{n=1}^{N} \beta_n \ln \chi_{ni} + \sum_{m=1}^{M} \phi_m \ln q_{mi} + \nu_i \tag{4.26}\]

The homogeneity constraint

\[
\sum_{n=1}^{N} \beta_n = 1 \tag{4.27}\]

The homogeneity constraint is imposed on the econometric model by substituting the constraint (4.27) into (4.26) and the model is written as follows;

\[
\ln \chi_{ni} = \beta_0 + \sum_{n=1}^{N-1} \beta_n \ln (\chi_{ni}/\chi_{ni}) + \sum_{m=1}^{M} \phi_m \ln q_{mi} + \nu_i - \mu_i \tag{4.28}\]

where \( \mu_i \) is a non-negative technical efficiency estimator. The parameters in the formula can be estimated using the ML technique and the radial input oriented technical efficiency measure would be:

\[
TE_i = \frac{1}{d_i^I} = \exp (-\mu_i) \tag{4.29}\]

Atkinson, Fare and Primont (1998) and Atkinson and Primont (1998) argue that the independent (explanatory) variables in 4.28 may be correlated with the composite error term (i.e. exogenous), which violate one of the main assumptions of the stochastic frontier model. Consequently it might lead to biased technical efficiency estimators in 4.29. However, Coelli (2000) claims that

---

58 This function is concave, linearly homogeneous and non-decreasing in inputs if \( \beta_n \geq 0 \) for all \( n \).

59 The constraint makes quasi-concave in outputs if non-linear functions of the first – and second – order derivatives of \( d_i^I \) with respect to the outputs are non-negative.

60 They used non-linear three-stage least squares using output oriented approach along with a set of shadow price ratio equations obtained from the distance function to estimate a system of equations consisting of (4.13).

61 The SFA model assumes that the composite error term is (iid) and the regressors are endogenous.
in the case of Cobb-Douglas and translog functional forms, the problems do not exist. O’Donnell and Coelli (2005) and Atkinson and Dorfman (2005) propose a Bayesian framework as a solution to the above problem if it is prevalent in the model.

To estimate the input distance function for panel data, the subsequent steps are followed. In the case of the stochastic input based distance function, the homogeneity of degree 1 in inputs is imposed and then a composed error model is arrived in which the inefficiency term is subtracted in the manner of stochastic composed error production function estimation. Consequently, using the definition of the inverse of the input based distance function as the measure of technical efficiency we can write for the typical producer:

$$\left[D_i(y,x,t)\right]^{-1} = \exp(-u_i)$$

*i.e.*

$$\ln D_i(y,x,t) = u_i$$

(4.30)

The following translog function with an additive random error term, $v$, as a second order approximation to any distance function can be used.

$$\ln D_i(y,x,t) \approx TL(y,x,t) + v$$

(4.31)

and by exploiting the property of homogeneity of degree +1 in inputs:
\[
\ln \left( \frac{D_t(y, x, t)}{x_K} \right) = TL \left( y, \frac{1}{x_K} x, t \right) + v = TL(y, \tilde{x}, t) + v 
\] 
(4.32)

Where we use the notation:

\[
\tilde{x}_k = \frac{x_k}{x_K}
\]

Expanding and re-arranging:

\[-\ln x_K = TL(y, \tilde{x}, t) + v - \ln D_t(y, x, t) \]

i.e.

\[-\ln x_K = TL(y, \tilde{x}, t) + v - u \]

(4.33)

In matrix notation where \( l_y' = (\ln y_1, \ldots, \ln y_R) \) and \( l_{\tilde{x}}' = (\ln \tilde{x}_1, \ldots, \ln \tilde{x}_{K-1}) \),

we can write the translog input distance function as:

\[-\ln x_K = \alpha_0 + \alpha l_y + \beta l_{\tilde{x}} + \frac{1}{2} l_y' A l_y + \frac{1}{2} l_{\tilde{x}}' B l_{\tilde{x}} + l_y' T l_{\tilde{x}} + \delta_1 t + \frac{1}{2} \delta_2 t^2 + \mu l_y t + \eta l_{\tilde{x}} t \]

(4.34)

Here the property of homogeneity of degree 1 in inputs is implicitly imposed by

the use of: \( \tilde{x}_k = (x_k / x_K) \) as the typical input variable. The property of symmetry

of the second order terms requires the restrictions: \( \alpha_{rs} = \alpha_{sr} \) and \( \beta_{jk} = \beta_{kj} \).
4.6.3. The Generalised Parametric Total Factor Productivity Index (GMTFPI)

The frontier techniques have been developed during the recent two decades to incorporate the measurement of productivity change. Traditionally measuring productivity incorporates a presumption that all the firms or DMUs are located on the frontier. In other words they are efficient. In such case the productivity growth was assumed as a result of the shift in the frontier or technical change. However, if the producer/firm or DMU is inefficient then the productivity change is incorporating not only technical change but efficiency change as well. These debates led indirectly to the development of SFA, which was discussed comprehensively in the previous section.

Thus, the acknowledgement of efficiency change is one of the reasons that causes productivity change takes place. The movement or growth in productivity over time can be decomposed into two main components. These are shift in the frontier (technical change) caused by improvement in technology of the DMU and movement of the DMU toward the frontier as catching up behaviour (efficiency change). In addition to these components a production technology is allowed to have scale effect i.e. decreasing return to scale. Hence, an additional component of productivity change can be considered in productivity analysis.

There are two main methodologies for the measurement of productivity change using frontier analysis techniques, namely the parametric approach which based on the SFA (the main discussion in this section) and the non-parametric approach.
which linked mainly to the Malmquist index (discussed extensively in the previous section).

Nishimizu and Page (1982) measured productivity growth by employing a parametric deterministic approach. They generalised the Solow model by measuring productivity growth as the sum of technical change and efficiency change. The Nishimizu and Page approach has been extended to employ stochastic frontier models in measuring the productivity change and decompose it into three components. Panel data techniques employing the MLE estimation are considered as the best option to be used in productivity analysis (Sena, 2003).

As discussed comprehensively in the non-parametric section, the use of Malmquist productivity index using distance function became very popular in the recent empirical literature. The main advantages of Malmquist productivity index (MPI) is that it does not require price data (if not available) and can be decomposed to into technical change and efficiency change. To avoid repetition this section will discuss directly the generalised Malmquist productivity index proposed by Orea (2002).


---

62 Solow productivity measure allows for inefficiency however productivity change and technical change were identical in his model.
63 Balk’s work that relied on Ray’s (1998) results.
This thesis employs Orea (2002) proposed index to construct the generalised Malmquist total factor productivity index using parametric estimation. According to Orea (2002), there is a wide consensus that a total factor productivity index which is generalised from the case of one input and one output should satisfy four properties: Idenity, Monotonicity, Separability, Proportionality.

The identity property requires that if inputs and outputs do not change, the TFP index is unity. Monotonicity requires that the weighted output growth rates and input growth rates are chosen in a manner, so that higher output and lower input unambiguously improve TFP. Separability, a property of the chosen technology set, permits the generalisation to the multiple-output, multiple-input case. Proportionality requires that the weights in the output and input growth indices add to unity.

The index number approach to productivity measurement proceeds as follows. The definition of Generalised Malmquist Total Factor Productivity change (GMTFPC) includes Technical efficiency change (TEC), technological change (TC), and scale efficiency change (SEC): $GMTFPC = TEC + TC + SEC$

These are log changes, i.e. percentages divided by 100. To put them in conventional index form we use:

$$GMTFPI\text{Index} = \exp(GMTFPC) = \exp(EC + TC + RTS).$$

Following Orea (2002) I use distance functions to measure GMTFPC. The input distance function is the largest deflation factor which must be applied to an
observed input bundle to project it onto the efficient frontier at the time \( t \). Strictly, \( D_I \) is the largest scalar divisor (\( \delta \)) of a bundle of inputs \( X \) such that \( \frac{X}{\delta} \) is still in the input requirements set, i.e. the deflation factor that brings the input bundle down onto the isoquant appropriate to period \( t \):

\[
D_I(y,x,t) = \max\{ \delta : \frac{x}{\delta} \in I'(y), \delta > 0 \}
\]  

(4.35)

In equation (4.35) \( \delta \) should exceed unity in order not to increase the observed input bundle after the division. Alternatively the inverse of the input distance function as technical efficiency:

\[
\theta(x,y) = \min\{ \theta : \theta x \in I(y) \}
\]  

(4.36)

In (4.21) \( \theta \) is the smallest positive scalar factor which can multiply the input bundle and still leave the resulting input combination on the isoquant boundary of the input requirements set. Since \( \delta \) exceeds unity, \( \theta \) will lie between zero and unity: \( \theta \in [0,1] \).

This inverse of the input distance function is the measure of *Farrell input based efficiency* of the firm, and \( 100(1-\theta) \) is the percentage inefficiency of the firm.

The properties of the input distance function that we use are these.

The input distance function is non-increasing in output:

\[
\epsilon_{\ln r} = \partial \ln D_I(t) / \partial \ln y_r \leq 0
\]  

(4.37)

The input distance function is non-decreasing in input
\[ \varepsilon_{kt} = \frac{\partial \ln D_t(t)}{\partial \ln x_k} \geq 0 \quad (4.38) \]

The input distance function is homogeneous of degree 1 in inputs:

\[ \sum_{k=1}^{K} \varepsilon_{kt} = 1 \quad (4.39) \]

The sign of the time derivative if technical change improves with time can also be written as follows:

\[ \frac{\partial \ln D_t(t)}{\partial t} \geq 0 \quad (4.40) \]

Following Orea (2002) the parametric productivity index is defined as a weighted index of output change minus a weighted index of input change. Using the input distance elasticities as weights, we have:

\[ \ln M_t = -\frac{1}{2} \sum_{r=1}^{R} (\varepsilon_{r+1} + \varepsilon_{rt}) \left( \ln \left( \frac{y_{r+1}}{y_{rt}} \right) \right) - \frac{1}{2} \sum_{k=1}^{K} (\varepsilon_{k+1} + \varepsilon_{kt}) \left( \ln \left( \frac{x_{k+1}}{x_{kt}} \right) \right) \quad (4.41) \]

The negative sign before the output index ensures that the weights on that index are positive. This index has a Tornqvist form but uses shadow prices based on the input distance function elasticities as the output and input weights instead of revenue and cost shares based on market prices. CCD (1982) demonstrate the relationship between Tornqvist indices of productivity change and Malmquist indices based on the translog approximation to the distance function. In particular, CCD demonstrate that the Malmquist input based productivity index is equivalent to the Tornqvist index multiplied by a returns to scale adjustment derived from
they measure of scale elasticity from the input distance function\(^{64}\). They demonstrate also an analogous relationship for the output based Malmquist productivity index\(^{65}\).

However the index defined above does not satisfy the property of proportionality. Although the input change weights sum to unity because the input distance function is homogeneous of degree one in inputs, the output weights do not sum to unity. They reflect the effect of non-constant returns to scale. Elasticity of scale is measured in the input distance function by the negative of the inverse of the sum of the output elasticities [See Färe and Primont (1995: 38-400) for a detailed proof]:

\[
E^t = -\left(\frac{1}{\sum_{r=1}^{R} E_{rt}}\right)
\]

and there is no homogeneity property to apply to the output elasticities.

Adapting the Orea (2002) approach to the input distance function, we can define a generalised parametric productivity index with the required proportionality property as:

\[
\ln G_I = \frac{\sum_{r=1}^{R} \left( E_{rt} / \sum_{s=1}^{S} E_{st} \right) \left( \ln(y_{rt+1} / y_{rt}) \right)}{\sum_{k=1}^{K} \left( E_{kt+1} + E_{kt} \right) \left( \ln(x_{kt+1} / x_{kt}) \right)}
\]

\((4.43)\)

\(^{64}\) Caves Christensen and Diewert (1982) theorem 4, p. 1407.

The output weights are now positive and add to unity by construction, and the
input weights are positive and add to unity because of the homogeneity of degree
one of the input distance function. With some re-arranging we obtain:

\[
\ln G_l = - \frac{1}{2} \sum_{r=1}^{r=R} (\varepsilon_{rt+1} + \varepsilon_{rt}) \left( \ln \left( \frac{y_{rt+1}}{y_{rt}} \right) \right) \\
- \frac{1}{2} \sum_{k=1}^{k=K} (\varepsilon_{kt+1} + \varepsilon_{kt}) \left( \ln \left( \frac{x_{kt+1}}{x_{kt}} \right) \right) \\
+ \frac{1}{2} \sum_{r=1}^{r=R} \left( \varepsilon_{rt+1} \left( \sum_{s=1}^{s=R} \varepsilon_{st+1} + 1 \right) / \sum_{s=1}^{s=R} \varepsilon_{st+1} \right) \\
+ \left( \varepsilon_{rt} \left( \sum_{s=1}^{s=R} \varepsilon_{st} + 1 \right) / \sum_{s=1}^{s=R} \varepsilon_{st} \right) \left( \ln \left( \frac{y_{rt+1}}{y_{rt}} \right) \right)
\]

(4.44)

Simplifying:

\[
\ln G_l = \ln M_l + \frac{1}{2} \sum_{r=1}^{r=R} \left( \varepsilon_{rt+1} \left( \sum_{s=1}^{s=R} \varepsilon_{st+1} + 1 \right) / \sum_{s=1}^{s=R} \varepsilon_{st+1} \right) \\
+ \left( \varepsilon_{rt} \left( \sum_{s=1}^{s=R} \varepsilon_{st} + 1 \right) / \sum_{s=1}^{s=R} \varepsilon_{st} \right) \left( \ln \left( \frac{y_{rt+1}}{y_{rt}} \right) \right)
\]

(4.45)

This index in (4.47) has a Tornqvist form with shadow price based elasticities
replacing market price based weights and it has the appropriate returns to scale
adjustment based on the input distance function. It therefore reflects the spirit if
not the letter of the CCD theorems. Using the scale factor notation in Coelli,
Estache, Perelman and Trujillo (2004), (4.47) can be rewritten as:

\[
\ln G_l = \ln M_l + \frac{1}{2} \sum_{r=1}^{r=R} \left( \varepsilon_{rt+1} \left( \sum_{s=1}^{s=R} \varepsilon_{st+1} + 1 \right) / \sum_{s=1}^{s=R} \varepsilon_{st+1} \right) \\
+ \left( \varepsilon_{rt} \left( \sum_{s=1}^{s=R} \varepsilon_{st} + 1 \right) / \sum_{s=1}^{s=R} \varepsilon_{st} \right) \left( \ln \left( \frac{y_{rt+1}}{y_{rt}} \right) \right)
\]

(4.46)

where the input distance scale factor is: 

\[
SF_t^I = \left( \sum_{r=1}^{r=R} \varepsilon_{rt} + 1 \right) / \sum_{r=1}^{r=R} \varepsilon_{rt} = 1 - E_t
\]

and \(E_t\) is the elasticity of scale at time \(t\).
The scale factor is related to but differs from that used in the production function approach. We note the following implications for returns to scale:

<table>
<thead>
<tr>
<th>Returns to scale</th>
<th>Elasticity of scale</th>
<th>Input distance scale factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing returns to scale</td>
<td>$E &gt; 1$</td>
<td>$SF^I &lt; 0$</td>
</tr>
<tr>
<td>Constant returns to scale</td>
<td>$E = 1$</td>
<td>$SF^I = 0$</td>
</tr>
<tr>
<td>Decreasing returns to scale</td>
<td>$E &lt; 1$</td>
<td>$SF^I &gt; 0$</td>
</tr>
</tbody>
</table>

To implement the generalised parametric index, the quadratic identity lemma is applied in the following form, as in the case in Caves, Christensen and Diewert (1982, pp.1412-3):

\[
- \ln \left( \frac{D_j(t+1)}{D_j(t)} \right) = -\frac{1}{2} \sum \left[ e_{t,t+1} + e_{t,t} \right] \left[ \ln \left( \frac{x_{t,t+1}}{x_{t,t}} \right) \right] - \frac{1}{2} \sum \left[ e_{y,t+1} + e_{y,t} \right] \left[ \ln \left( \frac{y_{t,t+1}}{y_{t,t}} \right) \right] - \frac{1}{2} \left[ \frac{\partial \ln D_j(t+1)}{\partial t} + \frac{\partial \ln D_j(t)}{\partial t} \right] \tag{4.47}
\]

\[
\ln M_I = -[\ln D_j(t+1) - \ln D_j(t)] + \frac{1}{2} \left[ (\partial \ln D_j(t+1)/\partial t) + (\partial \ln D_j(t)/\partial t) \right] \tag{4.48}
\]

Recall that the input distance is the inverse of the Farrell input based technical efficiency,

\[- \ln D_j(t) = \ln TE_j(t) \]

From the definition of the generalised parametric productivity index, and the rearrangement of the quadratic identity lemma, the Generalised Malmquist Total Factor Productivity Index is:

\[
\ln G_j = [\ln TE_j(t+1) - \ln TE_j(t)] + \frac{1}{2} \left[ (\partial \ln D_j(t+1)/\partial t) + (\partial \ln D_j(t)/\partial t) \right] \tag{4.49}
\]

\[+ \frac{1}{2} \sum_{r=1}^{K} \left( e_{r,t+1}SF_{t,t+1}' + e_{r,t}SF_{t,t}' \right) \left( \ln \left( \frac{y_{r,t+1}}{y_{r,t}} \right) \right) \]

The elasticities needed for the productivity index calculations are

Recall the translog input distance function
\[-\ln x_k = \alpha_0 + \alpha'y + \beta'y + \frac{1}{2}ly'Al + \frac{1}{2}lx'Blx + ly'Tlx + \delta_1t + \frac{1}{2}\delta_2t^2 + \mu'y + \eta'lx_t \]

(4.50)

The property of homogeneity of degree 1 in inputs is implicitly imposed by the use of: \( \tilde{x}_k = \left( x_k / x_k \right) \) as the typical input variable. The property of symmetry of the second order terms requires the restrictions: \( \alpha_{sr} = \alpha_{sr} \) and \( \beta_{jk} = \beta_{kj} \).

\[ e_r = \partial \ln D_i / \partial \ln y, r = 1 \ldots R \quad e_k = \partial \ln D_i / \partial \ln \tilde{x}_k, k = 1 \ldots K - 1 \quad \text{and} \quad \partial \ln D_i / \partial t. \]

These can be solved in terms of the coefficients of the translog distance function as:

\[
\begin{pmatrix}
    e_r \\
    e_k \\
    \partial \ln D_i / \partial t
\end{pmatrix} =
\begin{pmatrix}
    \alpha & A & \Gamma & \mu \\
    \beta & \Gamma' & B & \eta \\
    \delta_1 & \mu' & \eta' & \delta_2
\end{pmatrix}
\begin{pmatrix}
    1 \\
    ly \\
    lx \\
    t
\end{pmatrix}
\]

(4.51)

Finally the efficiency change component \( \ln TE_i(t + 1) - \ln TE_i(t) \) is generated from the inefficiency component of the composed error term in the stochastic frontier analysis specification of the translog regression.

Consequently, 4.50 achieves the familiar decomposition of total factor productivity change into efficiency change, EC, technical change, TC, and scale efficiency change

\[ GMTFPC = TEC + TC + SEC \]
4.6.4. Parametric Models Specification

The efficiency literature encompasses two contradicting views regarding the approach should be adopted when dealing environment variables. The first approach assumes that the environmental variables influence the shape of the production technology. Hence, advocate that such environmental variables should be included directly into the production function (e.g. Good et al. (1993)\textsuperscript{66}. In contrast the second approach suggests that these environmental variables affect the means of technical inefficiency (not the shape of technology). Hence, the followers of this approach recommend the inclusion of the environmental variables in model affect the mean inefficiency directly (Battese and Coelli (1995). According to Coelli, Perelman and Romano (1999) both approaches appear reasonable however adopting each of them depends on the objective of the researcher. Nevertheless, the authors suggest a likelihood test procedure to validate the true model specification.

This thesis tests four models with different specifications with a view to choosing the specification with the greatest fit. The four models are employed to consider two phenomena. First is heterogeneity in the banks in the two data sets. This is likely to be detected either because of the nature of the banks operations or because of the effect of liberalisation (El-Gamal and Inanoglu, 2005) and (Molyneux et al. 1997). The bank-specific variables are incorporated in each model according to each model specification. The second phenomenon is the set of environmental variables consisting of Openness and GDP growth in addition to

\textsuperscript{66} Good et al. (1993) applied their approach on European and US Air Carriers.
dummy of liberalisation and privatisation in the Egyptian case and a dummy of financial crisis in the Turkish case, all are incorporated in the models according to each model specification (i.e. Al-Jarrah and Molyneux, 2004 and Demir et al., 2007).

4.6.4.1. Time variant and Time invariant Models

1-Time invariant Model Battese and Coelli (1989) [M0]:

The stochastic input distance function is written as follows:

\[ 1 = D_i(y, x, t) \exp(-u_i + v_i) \]  

(4.52)

Where \( v_i \) is a random disturbance distributed as iid \( N(0, \sigma_v^2) \)

\( u_i \) is a non-negative inefficiency terms and assumed to be half normal iid \( N(0, \sigma_u^2) \).

2-Time variant truncated Battese and Coelli (1992) model [M1]:

The stochastic input distance function is written as follows:

\[ 1 = D_i(y, x, t) \exp(-u_{it} + v_{it}) \]  

(4.53)

Where \( v_{it} \) is a random disturbance distributed as iid \( N(0, \sigma_v^2) \).

\( u_{it} \) is a non-negative inefficiency terms and assumed to be truncated normal, and iid \( N(u, \sigma_u^+) \).

The time-invariant model, M0 is nested in the time variant model. The log likelihood ratio test will be applied to verify which model is more efficient to be used in the estimation.
4.6.4.2. Environmental effects model

3- Inefficiency Effect Battese and Coelli (1995) [M2]:

Assumes truncated normal distribution for inefficiency however, the mean inefficiency is specified as a function of environmental variables. \( u^\mu \) the model is specified as follows;

\[
\mu^\mu = \delta_0 + \sum_s \delta_s z_s + \omega^\mu
\]  

(4.54)

Where \( \omega^\mu \geq - (\delta_0 + \sum_s \delta_s z_s) \) is the unexplained component of technical inefficiency. The \( z_s \) variables include bank-specific characteristics as well as environmental variables that are possible sources of technical efficiency. \( \delta_0 \) and \( \delta_s \) are parameters to be estimated. It is worth noting that another sub-model to be estimated M2a assuming \( \delta_{gdpg} = \delta_{openk} = 0 \) is nested in M2.

3.a- Inefficiency Effect Battese and Coelli (1995) with time trend

Kumbhakar & Wang (2007) [M3]:

Following Al-Jarrah and Molyneux (2004), Kumbhakar & Wang (2007) suggestion this model aims to incorporate a flexible specification of time varying technical efficiency into the technical inefficiency effect model. This can be achieved by combining the Cornwell et al. (1990) specification (i.e. flexible temporal patterns) with technical inefficiency effect model (Battese and Coelli, 1995) (i.e. explaining efficiency differential).
\( u_{it} \) is specified as follows;

\[
\mu_{it} = \delta_0 + \sum_{s} \delta_s z_s + \psi_{i1} t + \psi_{i2} t^2 + \omega_{it} \quad (4.55)
\]

where \( \omega_{it} \geq -\left( \delta_0 + \sum_{s} \delta_s z_s + \psi_{i1} t + \psi_{i2} t^2 \right) \) is the unexplained component of technical inefficiency. The \( Z_s \) variables include bank-specific characteristics and environmental that explains the variability of mean technical inefficiency. \( \delta_0 \) and \( \delta_s \) are parameters to be estimated. Both \( t, t^2 \) allow for flexible temporal pattern of technical efficiency. \( \psi_{i1} \) and \( \psi_{i2} \) are parameters of time trends to be estimated.

It is worth noting that M2 (assuming \( \psi_{i1} = \psi_{i2} = 0 \)) is nested (i.e. special case) in M3 and to be tested using Log likelihood Ratio.

4- Production technology effect Coelli, Perelman and Romano (1999) and Good et al. (1993) [M4]:

This model considers the inclusion of the environment variables directly into the distance function. The model assumes that the environmental and bank-specific variables affect the shape of the production technology and consequently the banks’ management through shaping the distance function. The stochastic distance function becomes;

\[
1 = D_{i}(y, x, z, t) \exp(-u_{it} + \nu_{it}) \quad (4.56)
\]

\( u_{it} \) is truncated and assumed as the same in M1

Worth noting that M1 (assuming \( \beta_{z1} = \beta_{z2} = .... \beta_{zn} = 0 \)) is nested in M4 and to be tested using log Likelihood Ratio.
Another model to be estimated in this case is M4a ($\beta_{gdpg} = \beta_{openk} = 0$) which is nested in both M4 and M1 respectively.

5-Generalised Model Coelli, Perelman and Romano (1999) [M5]

The aim to construct model five is to build a model which is able to nest all other models. This procedure follows Coelli, Perelman and Romano (1999). Simply this model is a mix of M1, M2, M3 and M3. Hence, it considers including the environmental and bank-specific variables into the input distance function. Moreover, it assumes that these environmental variables as well as the time trend variables explain the inefficiency. It is worth noting that there are two sub-models to be estimated, M5a and M5b. These models are constructed to nest the special cases of models from one to four. M5a assumes $\psi_{11} = \psi_{12} = 0$ [i.e. $u_i$ follows Battese and Coelli (1995)].

On the other hand, M5b assuming macro-economic variables does not explain the variation in inefficiency (i.e. $\delta_{gdpg} = \delta_{openk} = 0$). All the models are nested in M5. Consequently to choose among the model with true specification following Coelli, Perelman and Romano (1999) the log likelihood ratio test is applied.

Overall the total number of stochastic frontier models to be estimated are thirteen models for each case.

- Model one (M1): Time variant {Special cases: M0 time invariant, M1a half normal distribution} (three Models)
• Model two (M2): Inefficiency effect Model {Special case: M2a Economic variable is not included} (two Models)

• Model three (M3): Inefficiency effect Model with time trend {Special case: M3a Economic variable is not included} (two Models)

• Model four (M4): time variant production technology effect {Special case: M4a Economic variable is not included} (two Models)

• Model one (M5): generalised model {Special cases: M5a time trend is not included in (inefficiency), M5b Economic variable is not included in (inefficiency), M5c Economic variable is not included in (the production technology) } (four Models)

4.6.4.3. Hypothesis Test

Test for the existence of inefficiency is applied in all models:

\[ H_0: \gamma = 0^{67} \]

\[ H_1: 0 < \gamma < 1. \]

If \( 0 < \gamma < 1. \) Then reject the null hypothesis and conclude the existence of inefficiency in the model.

4.6.4.4. Model’s restriction hypothesis

The log likelihood ratio test suggested by Battese & Coelli (1993) is used to test the model specification, where \( L_x \) denote the values of the likelihood function of

\[ ^{67} \text{In this case, the asymptotic distribution of } \hat{\lambda} \text{ is a mixed chi-square and the appropriate values are obtained from Kodde and Palm (1986) (See Battese & Coelli, 1993).} \]
the restricted model, and $L_u$ denote the values of the likelihood function of the unrestricted model.

$$LR = -2[\ln L_R - \ln L_U]$$ ...........................................(4.57)

$H_0: LR \geq \chi^2$

$H_1: LR < \chi^2$

Where: $\chi^2$ is the critical value of chi-square

The null hypothesis is rejected when $LR \geq \chi^2$ the unrestricted model is accepted as the true specified model.

### 4.7. Data and Variables

This thesis aims to analyse the efficiency and productivity of two banking sectors in two emerging economies, namely Egypt and Turkey. The data for Egypt is collected from the financial statements of the sample banks obtained from the Central Bank of Egypt (CBE). The numbers of the banks included in the Egyptian sample are twenty-five banks - all are commercial banks however, with different ownership status. The sample period is nineteen years, starting from the year 1984 to the year 2002 and covers pre- and post-liberalisation periods.

The Turkish banks data is collected from the Banks Association of Turkey (TBB) website. The numbers of banks included in the Turkish Sample are

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68 Some times referred to as TBB as Turkish abbreviation. This source is used in many studies. (among others Isik and Hassan, 2003, and 2002)
twenty-seven banks - all are commercial banks. The Turkish sample period covers ten years, starts from the year 1991 to the year 2000. The Turkish sample period represents the post-liberalisation period. During this particular period the occurrences of the financial crisis took place in the year 1994.

4.7.1. The Variables Specification and Definition

4.7.1.1. The Inputs and Outputs Specification

There is no consensus in the literature on the choice of inputs and outputs for the commercial banks (Berger and Humphrey, 1997). However, there are two popular approaches; namely, the production approach and the intermediation approach (Sealy and Lindley, 1997). The production approach assumes that the banks use physical inputs such as capital and labour (i.e. fixed assets, banks’ branches, and ATMs etc.) to produce of loans and deposits (outputs). The intermediation approach regards banks primarily as intermediaries (i.e. intermediating funds between savers and investors). In the intermediation approach context, banks use inputs (i.e. deposits, other funds, capital and labour) and transform them into outputs (loans, other income). Banks might be forced to reconsider its product mix. Therefore, the appropriateness of each method (i.e. production and intermediation) varies according to the circumstances (Tortosa-Ausina, 2002). Hughes and Mester (2008) emphasise that the essence of bank production is to ameliorate information asymmetries between borrowers and lenders and the ability to manage the risk associated with operations.

Each sample has its own characteristics due to the different economic environment in each country and the variables affecting the banking system in

---

69 The data set stops in the year 2000 due to the changes in banks financial reporting to consider the effect of inflation after the year, 2000.
each country. The preliminary aim of the thesis was to employ the intermediation approach in both cases. However, the preliminary parametric results from the Turkish data revealed poor monotonicity tests when employing the intermediation approach. Thereupon the intermediation approach is only adopted in the case of the Egyptian banks. In contrast the production approach, in which deposits is considered as outputs, is followed in the case of Turkish banks.

4.7.1.2. Inputs and Outputs Definition

The total loans (stock): is the traditional stock or balance sheet output measure used in both the intermediation/production models of banking production.
Total loans = the sum different loans’ maturity granted by the bank (Balance sheet)

The total deposits (stock): is the traditional stock or balance sheet input/output measure used in both the intermediation/production approaches of banking production.
Total deposits = the sum different deposits’ maturity by the bank (Balance sheet)

The other income (flows): The banks tend to diversify their investment portfolio to compete with other rivals. Hence, other sources of income became important earning activity. This flow measure of output does raise problems of definition. In some cases, other income flows can be recorded as losses, with negative values. In particular this is found in Turkish banks data. These negative values have arisen through losses on foreign exchange activities while the currency fluctuated widely during the sample period. We accommodate negative income flows in the
dataset by variable translation so that flows are recorded as the deviation from the minimum recorded flow in the sample (plus 0.01), and all other income values are positive.

Other income = non-interest income + income from other operations (Income statement)

The investments (stock): is the traditional stock or balance sheet output measure used in both the intermediation/production approaches of banking production.

Investment = the sum of investments in securities by the bank (Balance sheet)

The fixed assets (stock): is the traditional capital proxy input measure used in both the intermediation/production approaches of banking production.

Fixed Assets = Total fixed Assets – accumulated depreciation (Balance sheet)

Table 4- 2 the outputs and inputs in USDS Millions

<table>
<thead>
<tr>
<th>Outputs/Inputs</th>
<th>Variables</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Egypt</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>Total Loans</td>
<td>475</td>
<td>1155.2</td>
<td>1989.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Investments</td>
<td>475</td>
<td>396.8</td>
<td>840.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other Income</td>
<td>475</td>
<td>44.5</td>
<td>85.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General and Admin</td>
<td>475</td>
<td>44.5</td>
<td>98.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Assets</td>
<td>475</td>
<td>34.8</td>
<td>170.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Deposits</td>
<td>475</td>
<td>1968.7</td>
<td>3527.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td>Total Loans</td>
<td>270</td>
<td>1822.62</td>
<td>2693.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Investments</td>
<td>270</td>
<td>891.45</td>
<td>1287.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other Income</td>
<td>270</td>
<td>369.86</td>
<td>132.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General and Admin</td>
<td>270</td>
<td>142.65</td>
<td>189.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Assets</td>
<td>270</td>
<td>122.91</td>
<td>267.46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The general and administrative expenses (flow): is the traditional labour proxy input measure used in both the intermediation/production approaches of banking production.

General and Administrative expenses = Personnel expenses + administrative expenses (Income statement)
In the two data sets (Egypt and Turkey) all input and output variables are expressed in million USD$. The denomination of the variables in USD$ aim to control for the inflation impact on the real magnitude. The relative version of purchasing power parity states that the exchange rate between any two countries currencies will adjust to reflect the changes in the price levels of the two countries (Isik and Hassan, 2003).

In both countries, the Central bank of Egypt (CBE) and Central bank of Turkey (CBT) the real exchange rate (i.e. the currency is depreciated in line with inflation) is used to transform the data from original country currency to USD$. Thus, the expression of banks variables in USD$ (real rate) for both countries data means direct adjustment of the variables for inflation.

4.7.1.3. Environmental and Bank specific variable variables

1- Macroeconomic variables:
Gross Domestic Product Growth ($gdpg$): is the annual growth domestic product growth at real prices.

Openness ($openk$): is the annual total trade (exports plus imports) divided by GDP at real prices.

The variables for Egypt are from the year 1984 to the year 2002. The variables for Turkey are from the year, 1991 to the year 2000.
The source of \textit{gdpg} and \textit{openk} is the Penn World Table 6.2 (Heston, Summers and Aten, 2006)\textsuperscript{70}.

\textbf{2-Economic environment and policy change control variables}

\textit{Egypt:}

\textit{Liberalisation:} The liberalisation dummy variable (\textit{libera}) intends to capture the initial financial liberalisation years, takes value of unity for initial liberalisation year 1991, 1992 and zero for all other years (Kumbhakar and Wang, 2007).

\textit{Privatisation:} The privatisation dummy (\textit{privatis}) variable aims to capture effect of the privatisation policies, takes the value of unity for the active years of privatisation 1996, 1997, 1998 and zero for all other years (Kumbhakar and Wang, 2007).

\textit{Turkey:}

\textit{Financial crisis:} The crisis dummy variable (\textit{crisis}) aims to capture the initial effect of the crisis, takes the value of unity for the crisis years 1994, 1995 and zero for all years.

\textit{Stabilisation:} the stabilisation dummy variable (\textit{stabilis}) aims to control for the stabilisation programme period, takes the value of unity for the stabilisation programme implementation years 1996, 1997 and zero for all years.

\textbf{4.7.1.4. Bank-specific variables:}

\textit{Ownership Strata:}

\textit{Egypt:}

State-owned banks: the government has more than 75\% ownership.

Private banks: domestic investors have more than 55\% ownership

\textsuperscript{70} The Penn World Table 6.2 provides purchasing power parity and national income accounts converted into international prices for 188 countries for the years 1950-2004.
Foreign banks: foreign investors have more than 55% ownership

Joint-venture banks: government has more than 51% ownership and the rest either owned by foreign or domestic investors.

JV_T_F: joint-venture banks transformed to foreign ownership

JV_T_P: joint-venture banks transformed to private ownership (domestic shareholders)

P_T_F: originally private banks acquired by foreign investors.

Each category represented in the SFA models as a dummy variable, which takes the values of unity for each specific category and zero otherwise [1,0], the base case is foreign banks.\(^{71}\)

**Turkey:**

State-owned, Private, Foreign, and Savings and Deposits Insurance Fund (SDIF) banks. This is according to the Turkish banking Association classification (TBB).

Each category represented in the SFA models as a dummy variable, which takes the values of unity for each specific category and zero otherwise [1,0], the base case is foreign banks.

S_P_SDIF: originally state-owned banks later privatised and then transformed to SDIF.

P_SDIF: originally private banks and later transformed to the SDIF.

**Size strata**

**Egypt:**

Large banks are banks with total assets greater than or equal to USD$ 1 billion.

Medium banks are banks with total assets less than USD$ 1 billion and greater than USD$ 0.5 billion.

\(^{71}\) The foreign banks (base case) dummy is dropped from the models (used as reference group) to avoid exact multicollinearity problem (see Kumbhakar and Wang, 2007 and Sansarma, 2006).
Small size banks are banks with total assets less than or equal to USD$ 0.5 billion. Each category represented in the SFA models as a dummy variable, which takes the values of unity for each specific category and zero otherwise \([1,0]\), the base case is small banks.\(^{72}\)

**Turkey:**

Large banks are banks with total assets greater than or equal to USD$ 5 billion. Medium banks are banks with total assets less than USD$ 5 billion and greater than USD$ 2 billion. Small size banks are banks with total assets less than or equal USD$ 2 billion. Each category is represented in the SFA models as a dummy variable, which takes the values of unity for each specific category and zero otherwise \([1,0]\), the base case is small banks.

**4.8. Software:**

The non-parametric efficiency and productivity estimation was achieved using DEAP 2.1 software. The parametric efficiency estimation was obtained by utilising FRONTIER4.1 software by Coelli (1996). The Generalised Malmquist Total Factor Productivity was obtained by running an algorithm developed by the author on STATA 9.1 software [see appendix (6) and (7)]. Similarly the descriptive statistics and Kernel density distribution graphs were obtained by using STATA 9.1. Other graphs were created using Microsoft Excel 2003. The descriptive statistics, Spearman’s Rank correlation, and Kendall’s Rank correlation in chapter seven were computed using STATA 9.1 software.

\(^{72}\) Similar to the ownership category, the small size banks used as reference group, hence dropped from the models to avoid exact multicollinearity problem.
5. Chapter five: Liberalisation, Privatisation and the Efficiency and Productivity of Egyptian banks

5.1. Introduction:

The aim of this chapter is to evaluate the performance of the Egyptian banks during a period characterised by changes in economic policies. The chapter investigates whether the liberalisation policies embarked upon by the Egyptian government in the early 1990s have had a positive or negative impact on the performance of the Egyptian banks in terms of efficiency and productivity progress/regress.

It will also examine whether the liberalisation impact had influenced different forms of banks ownership and sizes with consistent magnitude. Another objective of this chapter is to examine the impact of the privatisation process of the joint-venture banks which started end of the year 1995, on the efficiency and productivity performance of the banking sector overall and on joint-venture banks in particular. A clustered analysis approach is conducted to reveal the impact of liberalisation and privatisation on the Egyptian banks with respect to each cluster size\(^{73}\), and ownership\(^{74}\).

Two methodologies, non-parametric DEA and parametric SFA, are employed to estimate the efficiency and productivity of Egyptian banks. The sample used in

\(^{73}\) Size are Large, Medium and Small.

\(^{74}\) Ownership are State-owned, Private, Foreign and JV.
the estimation contains twenty-five banks, which is made up of four major state-owned banks, eleven foreign banks, nine private banks and one joint venture bank\textsuperscript{75} during the period 1984-2002. The inputs and outputs specification follows the intermediation approach. The input oriented distance function is used to estimate both the parametric and non-parametric efficiency (i.e. technical efficiency) and productivity measures. The inputs are total deposits, fixed assets and general and administrative expenses. The outputs are total loans, securities and investment, and other income.

The chapter is organised as follows. The first section summarises the descriptive statistics of the sample data in an analytical approach to shed more light on the characteristics of the banking industry in Egypt. The second section discusses the non-parametric empirical results and compares the efficiency and productivity of the banks during the pre- and post-liberalisation eras. Similarly, the third section introduces the parametric empirical results. Finally, the conclusion is presented in the fourth section.

\textsuperscript{75} Mohandas Bank is a joint venture bank owned by state-owned banks and domestic private shareholders.
5.2. Descriptive Statistics:

According to the classification of the Central Bank of Egypt (CBE) in the year 2002, the Egyptian banking sector is composed of 62 banks of which 28 are commercial banks, 4 state-owned banks, 31 business and investment banks and 3 specialised banks. This study focuses on the performance of 25 commercial banks, which represent almost 90% of the total number of the commercial banks in Egypt. The sample also contains the four state-owned banks which are the major banks in Egypt in terms of size and market share. The state-owned banks’ market share in terms of total assets contracted from 70% in 1985 to 44% and 43% in 1993 and 2002 respectively after liberalisation and privatisation reforms took place. Nonetheless, the four state-owned banks still control almost 64% and 45% of the banking system deposits and loans respectively in 2002.

Table: 5-2-1 Summary of market share and growth: Total loans, deposits and assets by ownership

<table>
<thead>
<tr>
<th>Average</th>
<th>Total loans</th>
<th>Market Share</th>
<th>Growth</th>
<th>Total Deposits</th>
<th>Market Share</th>
<th>Growth</th>
<th>Total Assets</th>
<th>Market Share</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign</td>
<td></td>
<td>6.3%</td>
<td>13.4%</td>
<td>7.4%</td>
<td>16.3%</td>
<td>6.4%</td>
<td>13.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JV</td>
<td></td>
<td>1.3%</td>
<td>28.7%</td>
<td>1.2%</td>
<td>31.5%</td>
<td>1.0%</td>
<td>22.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>15.4%</td>
<td>14.8%</td>
<td>18.1%</td>
<td>11.1%</td>
<td>14.8%</td>
<td>9.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td></td>
<td>53.2%</td>
<td>11.3%</td>
<td>68.8%</td>
<td>8.5%</td>
<td>52.8%</td>
<td>7.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td></td>
<td>76.2%</td>
<td>11.8%</td>
<td>95.6%</td>
<td>9.7%</td>
<td>75.0%</td>
<td>8.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td></td>
<td>100.0%</td>
<td>12.2%</td>
<td>100.0%</td>
<td>9.8%</td>
<td>100.0%</td>
<td>8.3%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Central Bank of Egypt (CBE)

Table 5-2-1 above reveals that the Egyptian banking industry during the period (1991-2002) witnessed 8.3%, 9.8% and 12.2% average aggregate growth in total

76 For more details see Appendix (1) table (1)
assets, total deposits, and total loans respectively. After the financial liberalisation in 1991, most of the banks exhibited increase in assets and liabilities. However, there was no evidence of sustainable growth rate pattern towards the end of sample period - this is observed in all of the bank’s categories.

In contrast, a volatile pattern of both loans and deposits annual growth occurred after 1996. The private and foreign banks gained a slightly higher market share in deposits and loans market after the financial liberalisation in 1991. After the privatisation of the joint-venture banks end of 1995, the market share of private and foreign banks increased significantly in terms of total deposits and total loans. Though the Economic Reform and Structure Adjustment Programme (ERSAP) aimed to liberalise the financial sector overall including the banking sector, the Egyptian banking industry however, is still segmented hence the public sector banks seem to have the upper hand in the mobilising deposits as well as financial intermediation.

The cultural effect of the Egyptian households’ perspective over years among other reasons played a crucial role in the emergence of such a segmented industry. The majority of Egyptian households would rather deposit their savings in state-owned banks. They consider them safer and trustworthy compared to the private or foreign banks. Most public sector entities, for political reasons, rather deal with state-owned banks than private and foreign banks despite government’s allowing them to deal with both private and foreign banks since 1993. Thus, the public sector banks mobilise most deposits. This gives them advantage over both private

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77 For more details see Appendix 1 table (3)
78 For more details see Appendix (1) table (4)
and foreign banks in granting loans. The data reveals a significant decrease in the state-owned banks market share of total loans proportionate to the banking sector total loans from 64% in 1996 to 46% in 1997. The huge drop in state-owned banks market share of total loans could be due to the highly active capital market that introduced an alternative source of finance particularly for long term projects. Also, by 1997 the government was heavily involved in selling the shareholding of the state-owned banks in the joint-venture banks. The privatisation could also have had an indirect effect on the state-owned banks market share. This was represented in an indirect swap of their market share to other forms of ownership.

Nevertheless, the sample data demonstrates the dominance of the state-owned banks in the banking sector among the commercial banks in terms of total assets, total loans and total deposits.\(^{79}\)

<table>
<thead>
<tr>
<th>Table: 5-2-2 Descriptive statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outputs/Inputs</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Outputs</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Inputs</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

In million USD $\(\text{USD}$

Table 5-2-2 demonstrates high standard deviation for all variables. This reflects the heterogeneity among the sample banks. It is expected to find such high dispersion given the long time period of analysis, and circumstances (i.e.\(^{79}\)

\(^{79}\) For more details see Appendix (1) table (4)
liberalisation and privatisation) experienced by the overall industry. The significant dispersion is likely to affect the non-parametric results more than the parametric results. The non-parametric methodology is sensitive to outliers. Thus, it is likely to find significant levels of dispersion in the non-parametric results as well. In contrast, we expect little effect of the outlier and heterogeneity on the parametric results given the nature of the methodology and model specification (banks heterogeneity considered in the model).
5.3. The Non-parametric Empirical Results

5.3.1. The Efficiency of Egyptian Banks

<table>
<thead>
<tr>
<th>Period</th>
<th>CRS(^{80})</th>
<th>VRS(^{81})</th>
<th>Scale Eff(^{82})</th>
</tr>
</thead>
<tbody>
<tr>
<td>All period</td>
<td>0.80</td>
<td>0.86</td>
<td>0.93</td>
</tr>
<tr>
<td>Pre-liberalisation</td>
<td>0.73</td>
<td>0.79</td>
<td>0.92</td>
</tr>
<tr>
<td>Liberalisation</td>
<td>0.85</td>
<td>0.91</td>
<td>0.94</td>
</tr>
<tr>
<td>Post-privatisation</td>
<td>0.84</td>
<td>0.90</td>
<td>0.92</td>
</tr>
</tbody>
</table>

The non-parametric estimation of the Egyptian banks’ efficiency reveals that during the period of study on average the sample banks overall exhibited decreasing return to scale. The average variable returns to scale efficiency \((VRS\ eff)\) was 0.86. On the other hand, the constant returns to scale efficiency \((CRS\ eff)\) was 0.80.

The Egyptian banks average efficiency levels overall improved from \((VRS\ eff)\) 0.79 during the Pre-liberalisation period (1985-1990), to \((VRS\ eff)\) 0.91 during the post-liberalisation period (1991-1995). However, it seems that the privatisation process of the joint-venture (JV) banks started in 1996 and this process did not have significant impact in improving the efficiency levels on average for the overall Egyptian banking sector. For the post-privatisation period (1996-2002) there is no significant change in average efficiency - a minimal decrease in

\(^{80}\) Input oriented efficiency scores assuming CRS: \(L(\theta; C, s) = \theta L(y|C, s), \theta > 0, \lambda \geq 0\)

\(^{81}\) Input oriented efficiency score assuming VRS: \(L(\theta; V, s) = \theta L(y|V, s), \theta > 0, \lambda \geq 1\)

\(^{82}\) Scale Efficiency: \(S_i(y,x|s) = F_i(y,x|C,s) / F_i(y,x|V,s)\)
average efficiency is occurred. The variable return to scale efficiency \((VRS\ eff)\) was 0.90 while the constant returns to scale \((CRS\ eff)\) was 0.84.

Figure 5-3-1 VRS technical efficiency, CRS technical efficiency and Scale efficiency

Figure 5-3-1 depicts significant improvement on average efficiency initially after liberalisation reforms were introduced in the year, 1991. Nevertheless, the influence of liberalisation seems to be short term in its effect. The trend of average efficiency seems to decline after 1994 to reach its lowest level ever during the sample period in 1996 \((CRS\ eff=0.54 \& VRS\ eff=0.69)\)\(^{83}\). A reverse in the efficiency pattern occurs after 1996 (i.e. post-privatisation). Overall, the banking sector seems to be regaining the efficiency levels obtained during the liberalisation period. Nevertheless, the average efficiency could not reach the previous levels during post-liberalisation period. The sector seems to have responded negatively in the immediate post-privatisation period. A gradual improvement in the response to privatisation process started in late 1997. The average efficiency adopts a sideways pattern during the late stage of the privatisation period particularly after the year 2000. Scale efficiency improves

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\(^{83}\) See Appendix (8) table (1)
post-privatisation. On the contrary, there was no significant improvement in the scale efficiency levels post-liberalisation period and the banks maintained operating at decreasing returns to scale\textsuperscript{84}.

Overall the industry experienced decreasing returns to scale pre- and post-liberalisation and privatisation. It seems that the Egyptian banks focused on augmenting its size\textsuperscript{85} to meet the market demand regardless of efficiency levels. It is understandable that the segmented nature of the Egyptian banking industry, which is dominated by four “big size” state-owned banks. The medium and small either private or foreign banks forced to increase its sizes to be able to compete with the oligopolistic behaviour of the state-owned banks. The Egyptian banks kept operating at diseconomies of scale (more than the optimum size) even after liberalisation and privatisation policies\textsuperscript{86}.

Competition was not the only driver of the increase in bank sizes. Government regulations played a vital role as well. In the mid 1990s the CBE required the banks to increase their capital to meet the new minimum capital requirement of EGP 500 Million. This encouraged the banks below capital requirement to capitalise profits and issue bonus shares or seek capital increase via the IPO’s and consequently increase size. The findings of this study coincide with the results found in studies conducted on Turkey, Korea, China, Thailand, Taiwan, Jordan, Tunisia, Portugal, Hungary and India by [Zaim, (1995); Fethi et al (1998); and Isik and Hassan, (2003)]; Glibert and Wilson, (2002); Chen et al, (2005); Leightner and Lovell, (1998); Huang (2004); Maghareyh, (2004); Cook et al

\textsuperscript{84} See Appendix (8) table (1)
\textsuperscript{85} See Appendix (1) table (3) high growth in total assets post-liberalisation/privatisation
\textsuperscript{86} See Appendix (8) table(2)
(2005); Canhot and Dermin, (2003); Hassan and Marton, (2003); and Bhattacharyya (1997).

Nevertheless, other findings postulate that liberalisation has insignificant or minimal effect on efficiency levels. See for example; Yildirim (2002) and Denizer and Dinc (2002) in Turkey, Hoa, Hunter and Young (2001) in Korea and Rezities (2005) in Greece respectively. On the other hand, Kumbhakar et al. (2001) and Dugan and Fausten (2003) found evidence of efficiency regress in Greece and Malaysia respectively during the post-liberalisation eras.

5.3.2. Ownership, Size, Privatisation and Bank’s Efficiency:

The previous discussion showed that the liberalisation and privatisation policies adopted by the Egyptian government in 1991 and late 1995 respectively have managed to improve the efficiency of the banking sector overall. However, these results cannot be generalised on all forms of ownership. Hence, it is argued that different ownership might respond differently to liberalisation policies (Isik and Hassan, 2002).

It is worth noting that the discussion of the efficiency levels hereafter will be focused on the VRS efficiency rather than CRS efficiency. The reason is that the following section discusses SFA translog input distance function (IDF) estimated efficiency, hence SFA (IDF) is a curved productivity function similar to DEA-VRS where economies of scale are not considered to be relevant for efficiency (C.von Hirschhausen, 2006). Therefore, it would be appropriate to focus on DEA VRS for comparison reasons.
The non-parametric empirical results show that the magnitude of the liberalisation impact varies among the different forms of ownership. Table 5-3-2 summarise the average efficiency for ownership and size strata. The results reveal that the state-owned banks are the most efficient compared to other forms of ownership during the all sub-periods.

<table>
<thead>
<tr>
<th>Category</th>
<th>All Period</th>
<th>Pre-liberalisation</th>
<th>Post-liberalisation</th>
<th>Post-Privatisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>0.99</td>
<td>1.00</td>
<td>1.00</td>
<td>0.99</td>
</tr>
<tr>
<td>Private</td>
<td>0.81</td>
<td>0.70</td>
<td>0.91</td>
<td>0.85</td>
</tr>
<tr>
<td>P_TF</td>
<td>0.82</td>
<td>0.74</td>
<td>0.77</td>
<td>0.94</td>
</tr>
<tr>
<td>JV_TF</td>
<td>0.83</td>
<td>0.68</td>
<td>0.91</td>
<td>0.93</td>
</tr>
<tr>
<td>JV_TF</td>
<td>0.83</td>
<td>0.76</td>
<td>0.90</td>
<td>0.87</td>
</tr>
<tr>
<td>JV</td>
<td>0.95</td>
<td>0.94</td>
<td>1.00</td>
<td>0.93</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.88</td>
<td>0.92</td>
<td>0.84</td>
<td>0.88</td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>0.90</td>
<td>0.83</td>
<td>0.94</td>
<td>0.93</td>
</tr>
<tr>
<td>M</td>
<td>0.83</td>
<td>0.77</td>
<td>0.85</td>
<td>0.88</td>
</tr>
<tr>
<td>S</td>
<td>0.85</td>
<td>0.75</td>
<td>0.94</td>
<td>0.89</td>
</tr>
<tr>
<td>Total</td>
<td>0.86</td>
<td>0.79</td>
<td>0.91</td>
<td>0.90</td>
</tr>
</tbody>
</table>

The stable pattern of efficiency level of the state-owned banks in Egypt during the sample period of study coincides with Denizer and Dinc (2007) findings for Turkish banks. In contrast, Yildirim and Philippatos (2002) and Chen et al (2005) find no evidence of stable performance of the state-owned banks in the case of Turkish and Chinese banks respectively. Zaim (1995) and Yildirim (2002) find that the state-owned banks in Turkey outperform the private and foreign banks in terms of efficiency. The private and JV banks seem to be the most benefited from the liberalisation policies. In post-liberalisation period, the efficiency levels of these banks improved significantly. In contrast, the foreign banks efficiency

87 The notion JV banks refer to all joint venture banks (JV, JV_TF and JV_TP) i.e. including those banks that transformed to other ownership strata due to privatisation. The notion JV bank will be used to refer to the only JV bank in the sample.
level declines during the post-liberalisation period compared to the pre-liberalisation average efficiency. Except P_TF banks, the private banks and JV reacted positively to the competition and surpassed the foreign banks efficiency levels. Hence the liberalisation policies were successful in narrowing the efficiency gap between the state-owned banks and domestic banks. Isik et al. (2002) find evidence that foreign banks in Turkey tend to be the most benefited banks from liberalisation and outperform domestic banks (private and state) in terms of efficiency.

The second phase of reform represented in privatisation had a positive impact on some of the ownership groups. The private, JV_TF and JV banks group experienced decline in average efficiency during the privatisation period. Foreign banks efficiency level improved to 0.88 compared to the liberalisation period 0.84. The state-owned banks remained the most efficient with trivial decline in efficiency levels compared to the liberalisation period.

Another objective of the current chapter is to investigate the variation in performance among different size of banks’ strata. In general the large size banks seem to outperform the medium and small size banks in terms of efficiency levels on average during the period. All size strata experienced increase in efficiency level during the liberalisation period. However, the small banks seem to be the most benefited from liberalisation. The average efficiency level of the small banks significantly improved from 0.75 pre-liberalisation period to 0.94 post-liberalisation period. The small banks managed to catch-up with large size banks performance in the post-liberalisation stage. However, post-privatisation small
banks experienced decline in efficiency. Demir et al, (2005) and Isik and Hassan (2005) results shows that compared to other size forms, the large size banks performed better in a more liberal environment in Turkey.

Another aspect investigated in this section is the consequences of privatisation on the privatised banks’ efficiency levels. It is argued that privatisation tends to improve banks’ performance. Hence, under the new management banks will be keener to maximize/minimize the profits/costs. The privatisation of the joint-venture banks started in Egypt end of year 1995. The privatisation process prompted unique transformations in different forms of ownership. Some banks were sold to foreign investors (i.e. JV_TF) and other banks were sold to domestic private investors (i.e. JV_TP). During the same period foreign investors acquired one of the private banks (P_TF). There were ten JV banks transformed to majority foreign banks (JV_TF)\textsuperscript{88}, five JV banks transformed to majority private ownership banks (JV_TP)\textsuperscript{89}.

\textsuperscript{88} The minority stake is distributed among domestic investors.
\textsuperscript{89} The minority stake is distributed among foreign investors.
The results show that JV_TF and JV_TP experienced improvement in efficiency during pre-liberalisation. However, during post liberalisation, a rapid improvement in the efficiency pattern of these banks is depicted [see figure (5-3-2)]. The initial year of active privatisation witnessed sharp drop in efficiency levels in all forms of banks’ ownership. Surprisingly the privatised banks were the least affected and experienced the lower efficiency regress.

Figure 5-3-2 depicts that all forms of bank ownership experienced downward trend in efficiency levels two years following the year of liberalisation. The privatisation of the joint venture banks had a shock-effect on the industry and accelerated the efficiency regress in all banks forms. Wu and Parker (2007) elaborates that the level of competition and the market conditions affect the
performance of privatised banks during post-privatisation. Only one private
bank\textsuperscript{90} was acquired by majority foreign investors (P_TF). The performance of
this particular bank significantly improved during both sub-sample periods post-
liberalisation and privatisation as clearly observed from figure 5-3-2. The P_TF
bank gained most from ownership transformation compared to the privatised joint-
venture JV_TF and JV_TP.

With regard to the Egyptian case, it seems foreign ownership transformation
provides more successful results if the banks were originally privately owned.
The P_TF during post-privatisation period outperformed most of the ownership
groups. On average during the pos-privatisation period the P_TF bank became
second best practice below the state-owned banks. The probable explanation for
such findings could be the dominant consumer culture, which trusts domestic
banks rather than foreign banks. Another explanation could be due to the
diminishing effect of the new management culture (i.e. culture shock), hence it is
expected that the foreign banks would introduce different management practices
compared to those previously adopted by JV banks\textsuperscript{91}.

The results also reveal that in the case of the Egyptian banks privatisation; in
general the acquirers either foreign or domestic tended to be selective. The banks
acquired by private interests used to perform well even before the privatisation
policy was implemented. All banks were subject to efficiency decline in 1996.
The efficiency pattern in figure 5-3-2 depicts the foreign acquirer of joint venture
banks facing more resistance in terms of efficiency improvement compared to the

\textsuperscript{90} Ahly United bank is formerly known as Delta international bank
\textsuperscript{91} JV banks used to be majority owned by some of the state banks, hence it usually has the
bureaucratic public sector management practices prevailing.
domestic acquirer. The efficiency pattern seems to naturally decompose the sample period to three sub-periods of performance. However, this does not provide sufficient evidence that the initial gains of the liberalisation policies unraveled during the second stage of reform (i.e. privatisation).

Bonaccorsi di Patti and Hardy (2005) emphasise that it is difficult to unravel the effect of privatisation from the effects of reform. They clarify that the effect of privatisation might also be entangled with effect of foreign ownership hence; foreign investors often acquire the privatised banks. Despite the mixed results of privatisation in the case of Egypt however, they are in line with preceding literature. [See for example Bonin et al. (2005), Vo Thi and Vencappa (2007) and Hassan and Morton (2003)]. Clark et al. (2005) concluded that although poorly regulated banking sector diminishes the privatisation gains, privatisation has proven to improve performance.
5.3.3. Productivity of the Egyptian banks

This section aims to analyse the impact of liberalisation and privatisation policies on the productivity growth of the Egyptian banks. The Malmquist Total Factor Productivity Index (MTFPI) is calculated for each bank following FGNZ (1994). The MTFPI is decomposed to investigate the main driver(s) of productivity progress/regress. These components are efficiency progress relative to the best practice frontier (Technical Efficiency Change, ECI)\textsuperscript{92} and the shifts in frontier (Technological Change, TCI).

Further decomposition of the technical efficiency change to pure technical efficiency change (PECI)\textsuperscript{93} and scale efficiency change (SECI) is also done to detect the effect of scale on productivity growth. The former approach of decomposing the technical efficiency change component to pure technical efficiency change and scale efficiency change has been the subject of extensive debates\textsuperscript{94} in the recent development of relevant methodology literature. Nevertheless, it remains adopted by many studies given the fact the debate of the appropriateness of the underlying assumption of this approach remained inconclusive.

The non-parametric empirical results shows that the performance of the banking sector overall tends to be volatile in terms of productivity growth [Figure (5-3-3)].\textsuperscript{95} The Malmquist total factor productivity index (MTFPI) average during the sample period is 0.9930. This means that the Egyptian banking sector on average

\textsuperscript{92} Technical efficiency change (i.e. relative to a CRS technology)
\textsuperscript{93} Pure technical efficiency change (i.e. relative to a VRS technology)
\textsuperscript{94} The criticism to this approach is introduced in chapter 4.
\textsuperscript{95} The horizontal red line represents the level of zero growth. Below the red line is productivity regress. However, above the red line is productivity progress.
experienced approximately $\approx -0.7\%$ growth in total factor productivity over a period of eighteen years. High volatility is observed in pattern of technological change index (TCI), during the sample period. The productivity regress stems from regress in technology. On average during the sample period technology progress is $-2.3\%$ TCI of (0.977). The efficiency progress (ECI) contributed to the MTFPI by $1.7\%$ on average during the sample period. The further decomposition of ECI reveals on average during the sample period the SEC is $-0.017\%$.

During the pre-liberalisation period the Egyptian banking sector experienced slight productivity regress MTFPI (0.904). The main driver for the productivity regress was technological regress progress (TCI=0.964). A slight improvement in efficiency could not offset the diminishing effect of technological regress (PECI=1.013) and SECI is (0.997). The repressive environment during the pre-liberalisation period seemed to discourage the banks either from being productive or transfer technology.
Table: 5-3- 3 Mean MTFPI by period

<table>
<thead>
<tr>
<th>Period</th>
<th>ECI</th>
<th>TCI</th>
<th>PECI</th>
<th>SECI</th>
<th>MTFPI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-liberalisation</td>
<td>1.010</td>
<td>0.964</td>
<td>1.013</td>
<td>0.997</td>
<td>0.904</td>
</tr>
<tr>
<td>Post-liberalisation</td>
<td>1.022</td>
<td>1.056</td>
<td>1.017</td>
<td>1.006</td>
<td>1.079</td>
</tr>
<tr>
<td>Post-privatisation</td>
<td>1.018</td>
<td>0.917</td>
<td>1.021</td>
<td>0.997</td>
<td>0.933</td>
</tr>
<tr>
<td>Total</td>
<td>1.017</td>
<td>0.977</td>
<td>1.017</td>
<td>1.000</td>
<td>0.993</td>
</tr>
</tbody>
</table>

Moreover, the segmented market and the directed credit polices imposed by the government isolated the private and foreign banks and left the market controlled by the major state-owned banks. It is perceptible from the results that Egyptian banks experienced an initial response to the environmental shocks represented in liberalisation policies. Initially in the post-liberalisation period, particularly in year 1991, the banking system witnessed moderate growth in productivity by 6%. Pure efficiency change, technological change and scale efficiency change contributed to this growth by 2% improvement each. In contrast, the year 1992 saw a sudden growth in productivity (MTFPC) by 31%. TEC and TC contributed rather significantly growing by 18% and 15% respectively.

In contrast, in the initial post-privatisation period, particularly in the year 1996, the Egyptian banks experienced a huge shift in production technology TCI 1.44 (i.e. 37% improvement). Such impressive progress in technological change unfortunately was followed by drastic regress in technological change in the following years97. Concurrently with the progress in TC a sharp decline in efficiency change occurred in 1996. The technical efficiency change regress reaches its height of 26% in the same year and contributed to the decline of TFP growth of -9.69% in 1996.

96 The MTFPI and its component are calculated as the geometric means.
97 See Appendix (8) table (3)
The policies implemented by the Egyptian government to liberalise the financial sector in order to improve competition and stimulate banks to enhance performance had a successful influence particularly on the banks technological change (i.e. outward shift of the frontier). Technological change is the main contributor to post-liberalisation productivity growth compared to other components of total factor productivity growth (PECI and SECI). However, the liberalisation effect on productivity growth was rather short-term. Post-liberalisation (i.e. the medium and long run) pre-obtained productivity levels seem to disappear. From 1994 (i.e. two years post-liberalisation) the MTFPI and TCI recorded negative growth and this continued even through post-privatisation (i.e. second stage of reform). The negative trend in productivity stemmed mainly from negative technological change particularly post-privatisation however, at decreasing rate. The rather poor technical efficiency growth could not offset the downward shift in the frontier.

Perhaps, the legacy of a formerly repressed financial environment overshadowed the individual banks’ attempts to improve efficiency and resulted in unsustainable productivity growth. Moreover, it is argued that the Egyptian government adopted a gradual and cautious approach in liberalisation [Arestis, (2000); Caprio and Cull (2000); Mohieldin, (2000)]. This conservative approach seems to have a diminishing effect on the reform impact particularly in the long run. The substantiated volatile pattern of MTFPI, ECI and TCI in the case of Egyptian banks is similar to the same pattern observed in Turkish banks by Isik et al. (2002). The possible explanation for such volatile pattern is that the Egyptian banks are learning by doing. Moreover, the existence of the divergent department
depicted in the trend of efficiency growth versus technological progress pattern can be explained as lack of experience on the part of Egyptian banks. Hence, it seems that Egyptian banks need time to adapt to new technologies and to a more competitive environment.

Similar to the present study results, Tsionas et al. (2003) finds positive however, unsustainable productivity in the case of Greece. Canhot and Dermine (2003) find that the efficiency growth contributed most to the productivity growth in the case of Portugal in contrary to the present study findings. In contrast, Hasan and Morton (2003) found long-term improvement in the post-liberalisation productivity of the Hungarian banks.

5.3.4. Ownership, Size and Bank’s Productivity:

The investigation of efficiency and banks ownership and size forms presented in section 5-3-1 suggests that liberalisation policies had dissimilar impacts on different forms of banks’ ownership and size. Table 5-3-5 demonstrates the productivity growth per ownership group of the Egyptian banks. Overall during the period of study, on average only JV_TP banks are slightly productive (1%) compared to all others. Technological regress on average during the sample period is the main driver of the negative productivity growth.

The poor productivity performance in the pre-liberalisation and post-privatisation periods diminishes the advancement in productivity obtained by all forms of ownership during the liberalisation period. The results show that liberalisation policies improved the productivity of all forms of bank’s ownership except the JV
bank with productivity regress, –4%. During post-liberalisation foreign, private and state-owned banks experienced productivity progress of (9.3%), (3.6%) and (1.4%) respectively. The banks that had ownership transformation during the later years performed well during the liberalisation period. The P_TF bank is the most productive during liberalisation with MTFPI, 14.3%. The JV_TF and JV_TP obtain productivity growth of 12.1% and 6.7% respectively during the liberalisation period. Apparently, state-owned banks are the least productive followed by private banks.

Table: 5-3-4 MTFPI and its components by ownership over sub-periods

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Overall</th>
<th>Pre-liberalisation</th>
<th>Post-liberalisation</th>
<th>Post-privatisation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MTFPI</td>
<td>ECI</td>
<td>TCI</td>
<td>PECI</td>
<td>SECI</td>
</tr>
<tr>
<td>State</td>
<td>1.00</td>
<td>0.99</td>
<td>1.00</td>
<td>1.00</td>
<td>0.99</td>
</tr>
<tr>
<td>Private</td>
<td>1.03</td>
<td>0.97</td>
<td>1.04</td>
<td>0.99</td>
<td>1.00</td>
</tr>
<tr>
<td>P_TF</td>
<td>1.00</td>
<td>0.81</td>
<td>1.00</td>
<td>1.00</td>
<td>0.81</td>
</tr>
<tr>
<td>JV_TP</td>
<td>1.03</td>
<td>0.99</td>
<td>1.02</td>
<td>1.01</td>
<td>1.01</td>
</tr>
<tr>
<td>JV_TF</td>
<td>1.02</td>
<td>0.97</td>
<td>1.02</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>JV</td>
<td>1.00</td>
<td>0.98</td>
<td>1.00</td>
<td>1.00</td>
<td>0.98</td>
</tr>
<tr>
<td>Foreign</td>
<td>1.01</td>
<td>0.98</td>
<td>1.01</td>
<td>1.00</td>
<td>0.98</td>
</tr>
</tbody>
</table>

| State     | 1.00    | 0.98               | 1.00                | 1.00               | 0.98  |
| Private   | 1.11    | 0.96               | 1.10                | 1.01               | 1.07  |
| P_TF      | 0.89    | 0.55               | 0.89                | 1.00               | 0.49  |
| JV_TP     | 1.01    | 0.99               | 1.01                | 1.00               | 1.01  |
| JV_TF     | 1.01    | 0.98               | 1.02                | 0.99               | 1.00  |
| JV        | 0.99    | 0.99               | 0.99                | 1.00               | 0.98  |
| Foreign   | 0.90    | 1.09               | 0.91                | 0.99               | 0.98  |

| State     | 0.99    | 1.03               | 1.00                | 0.99               | 1.01  |
| Private   | 0.98    | 1.06               | 0.98                | 1.00               | 1.04  |
| P_TF      | 1.11    | 1.04               | 1.11                | 1.00               | 1.15  |
| JV_TP     | 1.02    | 1.04               | 1.02                | 1.01               | 1.07  |
| JV_TF     | 1.03    | 1.09               | 1.02                | 1.02               | 1.13  |
| JV        | 1.02    | 0.94               | 1.02                | 1.00               | 0.96  |
| Foreign   | 1.12    | 0.98               | 1.12                | 1.00               | 1.10  |

| State     | 1.01    | 0.96               | 1.00                | 1.01               | 0.97  |
| Private   | 1.01    | 0.91               | 1.04                | 0.97               | 0.92  |
| P_TF      | 1.03    | 0.95               | 1.02                | 1.00               | 0.98  |
| JV_TP     | 1.04    | 0.94               | 1.03                | 1.01               | 0.98  |
| JV_TF     | 1.01    | 0.88               | 1.02                | 0.99               | 0.90  |
| JV        | 1.00    | 0.99               | 1.00                | 1.00               | 0.99  |
| Foreign   | 1.03    | 0.89               | 1.01                | 1.02               | 0.91  |

| Total     | 1.01    | 0.94               | 1.01                | 1                  | 0.95  |
The sources of productivity improvement during the liberalisation period varied among the ownership forms. In the case of the state-owned and private banks, the technological progress is the main driver of productivity growth TCI is 1.03 and 1.06 respectively. Similarly the TCI for the JV_TF and JV_TP is 1.09, 1.04 respectively and thus, contributed most to the productivity progress of these banks. In contrast, efficiency progress is the main source of productivity growth in the P_TF bank and the foreign banks with PECI 1.11 and 1.12 respectively. The scale efficiency change is almost an insignificant contributor to productivity growth in all ownership forms.

It is evident from the results that the P_TF bank has benefited most from the liberalisation policies given the significant improvement in productivity growth compared to other rivals in the industry. The P_TF bank experienced severe productivity regress during the pre-liberalisation period, the impressive recovery in the banks performance during the liberalisation period reflects the successful response of the bank’s management towards competition. During the period the domestic banks in Egypt invested heavily in improving the IT systems and ATM installations in order to compete with foreign banks which focused consumer finance and provide ATM and credit cards services to its customers.

Isik et al. (2002) find that foreign banks in Turkey benefited most from liberalisation policies and tend to outperform all ownership rivals. Unlike the Egyptian case, the authors also find that the major source of productivity gains in the Turkish banks was efficiency change in the post-liberalisation stage. Similar to the findings in this section for Egyptian banks, Gilbert and Wilson (1998) find
that technological change was the main driver of productivity growth among Korean banks.

During post-privatisation, all ownership strata experienced productivity regress mainly from backward shift in the technology. The private, JV_TF and foreign banks achieve the most productivity regress –9%, -11% and –9% respectively. The privatisation of joint venture banks had mixed effect. Despite all the privatised banks attained productivity regress, the JV_TP strata has the least productivity regress –2.3% compared to JV_TF group. Private banks succeeded in surpassing foreign banks in terms of efficiency change, they achieved 3% compared to 2% for the foreign banks.

<table>
<thead>
<tr>
<th>Table 5-3-6 MTFPI by Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MTFPI and its components by Size</strong></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
</tr>
<tr>
<td>Size</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td><strong>Pre-liberalisation</strong></td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td><strong>Post-liberalisation</strong></td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td><strong>Post-privatisation</strong></td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Table 5-3-6 reveals that small sized banks have benefited most from liberalisation policies compared to large and medium banks in terms of productivity growth. Both medium and small banks obtained similar post liberalisation technical
efficiency growth, with 4% each. However, technological progress (9%) contributed most to the productivity growth (13.2%) of the small banks post-liberalisation performance. Nevertheless, it is also observed that most of the banks in terms of size categories have experienced significant post-liberalisation technological progress compared to the pre-liberalisation period averages.

In the long-term particularly during the privatisation period a rather technological regress in all size categories is occurred. The in-ward shift in the frontier (technological regress) has contributed to an overall regress in productivity growth. Therefore, in all size categories the progress in efficiency is offset by the technological regress. The medium size banks achieved on average higher efficiency growth (9%) compared to the small and large banks (2%), (5%) respectively. The results contradict with Demir et al (2005), Isik and Hassan (2003) findings in the case of Turkey. Hence, these two studies findings assert that liberalisation had more impact in improving the productivity of large banks compared to small banks.

In summary, the productivity analysis of Egyptian banks revealed that the liberalisation policies managed to improve their performance. Hence, post-liberalisation productivity growth reached 7.6% compared to pre-liberalisation productivity regress. However, the influence of liberalisation seemed to be short-termed in case of Egyptian banks. Technological change was the main source of productivity growth. The liberalisation effect impacted on different ownership and size forms with varied magnitude.
The small banks tend to be the most productive in the post-liberalisation. Post-privatisation witnessed a significant decline in productivity. All forms of ownership and size obtained negative productivity growth. Moreover, all the privatised banks experienced productivity regress in the post-privatisation compared to the preceding period (i.e.-post liberalisation). The main source of productivity regress is technological regress. The foreign acquirer seems to be selective. Hence most of the joint-venture banks that transformed to foreign ownership tend to achieve superior productivity growth compared to other forms of ownership.
5.4. The Parametric Empirical Results

This section aims to provide analytical discussion for the parametric results of efficiency and productivity estimation. A main feature of the parametric estimation of efficiency is that it requires pre-assumption of the model. Furthermore, it allows for testing the statistical significance, either the model fitness or the model’s parameters. As previously mentioned in the methodology chapter, this chapter employs the intermediation approach in both parametric and non-parametric estimation. In the parametric estimation the input distance function is exploited. Hence, it does not require information about input prices nor prior assumption regarding the competition.

This section presents the results of parametric estimation of thirteen models of which the main discussion will focus on the main 5 models. Other models are nested and statistically rejected. The productivity analysis is presented later in this chapter using the parameters from the selected model to estimate the Malmquist productivity index and its decomposition into efficiency change, technological change and scale change.

The estimation results of five different model specifications are presented in table (5-4-1). The five models represent four cases. Case 1 assumes that environmental and bank-specific factors do not affect efficiency or the production technology. Case 2 assumes that environmental and bank-specific factors affect banks’ efficiency. Case 3 assumes that environmental and bank-specific factors in addition to time trend affect banks’ efficiency. Case 4 suggests that the
environmental and bank-specific factors have direct impact on the banks’ production technology.

**Case 1: Efficiency estimates without environmental effect.**

In Case 1 three models are estimated in all of which the parameters of the input distance function does not incorporate environmental and bank-specific factors. Model one (M1) [table (5-4-1)] estimated as the base model assuming a time-variant efficiency component $\mu$, which follows a truncated normal distribution following Battese and Coelli (1992). However, to be able to test the efficiency of the model another three sub-models (nested in models) are estimated and against which are tested using the likelihood ratio test.

The first model (M0) assumes a time invariant efficiency, hence $\eta$ is restricted to zero ($\eta = 0$) [i.e. Battese and Coelli (1998)]. However, the second model (M1a) suggests a half normal distribution with $\mu$ restricted to zero ($\mu = 0$) [i.e. Pitt and Lee (1981)]. The null hypothesis is that model one (M1) is consistent, however not efficient, is tested against both M0 and M1a using the log likelihood test. The log likelihood ratio test (LR) for both M0 and M1 [table (5-4-2)] are rejected at 99% significance level. The likelihood test suggest that model one M1 is consistent and efficient (i.e. is preferred) to estimate the efficiency of the Egyptian banks.
### Table: 5-4- 1 The Estimated Efficiency Models

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sym</th>
<th>M1</th>
<th></th>
<th>M2a</th>
<th></th>
<th>M3a</th>
<th></th>
<th>M4</th>
<th></th>
<th>M5b</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>coeff</td>
<td>Sign level</td>
<td>coeff</td>
<td>Sign level</td>
<td>coeff</td>
<td>Sign level</td>
<td>coeff</td>
<td>Sign level</td>
<td>coeff</td>
<td>Sign level</td>
</tr>
<tr>
<td>Cons</td>
<td>α</td>
<td>1.072 ***</td>
<td>0.621 ***</td>
<td>0.7018 ***</td>
<td>0.661 ***</td>
<td>0.993 ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny1</td>
<td>β1</td>
<td>-0.600 ***</td>
<td>-0.635 ***</td>
<td>-0.621 ***</td>
<td>-0.528 ***</td>
<td>-0.571 ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny2</td>
<td>β2</td>
<td>-0.029 *</td>
<td>-0.097 ***</td>
<td>-0.099 ***</td>
<td>-0.074 ***</td>
<td>-0.086 ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny3</td>
<td>β3</td>
<td>-0.137 ***</td>
<td>-0.226 ***</td>
<td>-0.234 ***</td>
<td>-0.107 ***</td>
<td>-0.201 ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnX1</td>
<td>Β4</td>
<td>0.263 ***</td>
<td>0.319 ***</td>
<td>0.325 ***</td>
<td>0.271 ***</td>
<td>0.360 ***</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>lnX3</td>
<td>β5</td>
<td>0.612 ***</td>
<td>0.598 ***</td>
<td>0.589 ***</td>
<td>0.638 ***</td>
<td>0.576 ***</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>T</td>
<td>β6</td>
<td>-0.043 ***</td>
<td>-0.028 ***</td>
<td>-0.044 ***</td>
<td>-0.042 ***</td>
<td>-0.035 *</td>
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<tr>
<td>lnY11</td>
<td>β7</td>
<td>-0.002 ins</td>
<td>-0.058 ins</td>
<td>-0.060 *</td>
<td>0.033 ins</td>
<td>-0.028 ins</td>
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<td>β8</td>
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<td>0.682 ***</td>
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<td>Mu</td>
<td>μ</td>
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<td>0.375 **</td>
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</table>

98 Significance level (*90%, (**) 95% and (***) 99%)
Furthermore the likelihood test suggests that $\mu_u$ is time-variant and a truncated normal distribution are more suitable for the inefficiency estimates. In table 5-4-2 the null hypothesis that the parameters can be estimated using ordinary least squares $^99$ (OLS) $\gamma = \mu = \eta = 0$ are also rejected at 99% significance. Hence, $\gamma \neq 0$. This indicates that $\sigma_u^2 \neq 0$ and consequently asserts the existence of inefficiency.

Model one (M1) which does not incorporate environmental factors, is rejected in favour of case 2, 3 and 4 models [table (5-4-3)] on the basis of likelihood ratio test. These results seem to imply that environmental and bank-specific factors cannot be neglected in estimating banks’ productivity and efficiency. Furthermore the likelihood test suggests that $\mu_u$ is time-variant and a truncated normal distribution are more suitable for the inefficiency estimates. In table (5-4-2) the null hypothesis that the parameters can be estimated using ordinary least squares (OLS) $\gamma = \mu = \eta = 0$ are also rejected at 99% confidence level, hence $\gamma \neq 0$

**Case 2: Inefficiency Effect Models:**

The input distance function is estimated assuming that environmental and bank-specific factors affect inefficiency (Battese and Coelli, 1995). Two models are estimated in case two (M2 and M2a) wherein both models the assumption that

---

$^99$ The FRONTIER software uses a three-step estimation method to obtain the final maximum-likelihood estimates. First, estimates of $\alpha$-parameter are obtained by OLS. A two grid search for $\gamma$ is conducted in the second step with $\alpha$-estimates set to OLS values and other parameters set to zero. The third step involves an iterative procedure, using Davidson-Fetcher- Powel Quasi-Newton method to obtain final maximum-likelihood estimates with the values selected in the grid search as starting values.
time trends explain inefficiency is neglected. The Likelihood ratio test rejects the null hypothesis that $\gamma = 0$ for both models, therefore implying that inefficiency is present in both. Furthermore, the null hypothesis that $\delta' = 0$ (where $\delta'$ includes $\delta_\delta = \delta_i = \delta_\delta = \ldots = \delta_\delta$) is rejected at 99% level consequently the result suggests that the environmental and bank-specific factors explaining inefficiency is also present [see table (5-4-2)]

Model two (M2) is evaluated against M2a. The likelihood ratio test fail to reject the null hypothesis that ($\delta_{openk} = \delta_{gdpg} = 0$). Therefore, model 2 (M2) is rejected in favour of M2a and M2a is truly specified [table (5-4-2)]. The macroeconomic variables gdpg and openk do not explain the inefficiency of the Egyptian banks. Case 1 models are not nested in case 2 models (Coelli, Perelman and Romano, 1999). Nevertheless, both models M2 and M2a are rejected in favour of models M3 and M3a using the same test.

**Case 3: Inefficiency Effect Models with time trend**

Two models (M3 and M3a) are estimated employing the input distance function. The main assumption of case three models that time trends explain inefficiency. Following Kumbhakar and Wang (2007), time trend ($t$ and $t^2$) are added to the factors affecting inefficiency. Models M2 and M2a are nested in M3 and M3a respectively. The likelihood ratio test rejects the null hypothesis that $\psi_1 = \psi_2 = 0$ at confidence level 99% [table (5-4-2)]. Both models M3 and M3a

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100 The critical value for any test involving $\gamma = 0$ is obtained from Table1 of Kodde and Palm (1986:1246). Hence, the asymptotic distribution of $\lambda$ is approximately a mixed chi-square distribution (Battese & Coelli, 1995).

101 The parameters of M2a is presented in table (5-4-1).
are favoured against M2 and M2a respectively. The results also assert the existence of inefficiency effects in both models. The null hypothesis that \( \gamma = \delta' = \psi' = 0 \) is rejected at 99% confidence level suggesting that time trend and economic and bank-specific factors affect inefficiency.

<table>
<thead>
<tr>
<th>Table: 5-4-2 Models-specific Assumptions Hypothesis test</th>
</tr>
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<tbody>
<tr>
<td><strong>Given Model</strong></td>
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<tr>
<td>M1 20.0852</td>
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<td>M2 -77.3052</td>
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<td>M3 -68.4156</td>
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<tr>
<td>M4 80.1898</td>
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</table>

The likelihood ratio test fail to reject the null hypothesis that \( \delta_{openk} = \delta_{gdpg} = 0 \). Consequently, M3 is rejected in favour of M3a [table (5-4-2)]. This confirms that macroeconomic variables do not explain the variation of mean inefficiency of the Egyptian banks. Coelli, Romano and Perelman (1999) described the technical efficiency obtained from Case 2 and case 3 models as “gross measure of efficiency”- in other words the technical efficiency is gross of environmental and bank-specific variables.
Case 4: Environmental Variables Influence the Shape of the Production Technology

Case 4 assumes that the environmental and bank-specific variables influence the shape the production technology. Two models are estimated M4 and M4a in which environmental and bank-specific variables are incorporated directly into the input distance function [e.g. Good et al. (1993), Coelli Perelman and Romano (1999), and Hattori (2002)] \(^{102}\). In both models the null hypothesis that \( \gamma = \zeta' = 0 \) (where \( \zeta' \) includes \( \zeta_1 = \zeta_2 = \zeta_3 = \ldots \zeta_i \)) is rejected at 99% confidence level. This result indicates that the existence of inefficiency, furthermore suggesting that environmental and bank-specific variables influence the shape of technology in the Egyptian banks.

M4a is rejected in favour of M4 hence the null hypothesis that \( \zeta_{openk} = \zeta_{gdp} = 0 \) is rejected at 99% confidence level table 5-4-2. This implies that the macroeconomic variables in addition to bank-specific variables influence the shape of production technology. Following Coelli, Perelman and Romano (1999) the technical efficiency obtained from M4 described as “net measure of technical efficiency” (i.e. net of environmental and bank-specific variables).

\(^{102}\) Note that Model 4 assumes separability of the environment and bank specific variables (i.e. these variables do not interact with the input distance function variables). A more general model is non separability where the environmental variables interact multiplicatively with the input distance parameters. Nevertheless, it is out of the scope of this study.
Multiple models for input distance functions were estimated in order to identify the most fitting model to measure bank efficiency for Egypt. This was also the reason for incorporating dummy variables to control for bank heterogeneity and the reforms policy effects. This approach facilitates testing the robustness of each model specification using the likelihood ratio test LR. The approach is adopted by many studies, for instance, Coelli, Perelman and Romano (1999), Hattori (2002) and Sensarma (2006).

The estimated parameters of the input distance function of four different model specifications (four cases) are presented in the previous section table 5-4-1. Table 5-4-2 presents the hypothesis test for each model. Table 5-4-3 presents the results of the hypothesis test for the validity of each model-specification. Case one models are not nested in case two models and it cannot be tested against each other. Similarly Case four models are not nested in Case three models. Case one

\[ LR = -2[\ln R - \ln U] \]

where R is restricted and U is unrestricted.
model could be treated as a special Case 4 models. Therefore, the construction of
the generalised model, which combines the four cases model specifications, is
deemed essential in order to conduct such test.

Following Coelli, Perelman and Romano (1999) and others, the generalised
model (M5) is constructed. Model five incorporates environmental and bank-
specific variables directly into the input distanced function (i.e. assuming it affect
the shape of technology). In addition, the model also assimilates the same
environmental and bank-specific variables to affect the inefficiency. According to
the likelihood test [see table (5-4-3)] M2a is rejected in favour of M3a at 99%
confidence level (i.e. $\psi_1, \psi_2 \neq 0$). Furthermore, M3 is rejected in favour of M3a
at 99% confidence (i.e. $\delta_{open} = \delta_{gdpg} = 0$). These results imply that the model
specifications according to case 3 are more preferred in measuring the Egyptian
banks efficiency. In other words it is preferable to consider the time trend effect
in measuring the efficiency of the Egyptian banks using inefficiency effect model.
Moreover, the macroeconomic variables openk and gdpg are not influencing the
variability in average inefficiency in the Egyptian case.

Hence, case 1 models are nested in case four models - the likelihood ratio test
reject the M1 in favour for M4. Furthermore, M4a is favoured over M4 at 99%
confidence level. These results suggest that in the Egyptian case the
environmental and bank-specific variables affect the shape of production
technology (i.e. $\zeta' \neq 0$) Consequently, ignoring such effect will result in biased
efficiency measures. Unlike case 3 model specifications, the macroeconomic
variables play vital rule in shaping the production technology (i.e. \( \xi_{spwld}, \xi_{gdp} \neq 0 \)).

The likelihood test reveals that Case four models (M4, M4a) are the truly specified. Consequently are the preferred models in measuring the Egyptian banks efficiency at 99% confidence level. Hence, M1, M2a and M3a, are all rejected in favour of M5 (The generalised model) at 99% confidence level. In contrast the likelihood ratio test fails to reject M4. Consequently, M4 is the preferred model to measure the efficiency of the Egyptian banks. Hence, the environmental and bank-specific variables are most likely affecting the shape of technology rather than the variability in average inefficiency. Based on these findings M4 parameters are used to estimate the Malmquist productivity index following Orea (2002) in later section in this chapter. The next section presents a comparison between the efficiency estimates from the four cases. The rest of the next section will be focused in discussing the efficiency of the Egyptian banks according to M4 estimation.

**5.4.2. Comparison between the Estimated Efficiency**

According to Coelli, Perelman, and Romano (1999) the estimated technical efficiencies are expected to vary for each model specification. Models M2a and M3a are expected to provide gross efficiency. Models M4 and M1 produce net technical efficiency. Table 5-4-4 presents summary statistics of the technical
efficiency for each model. It is also to find $\gamma^{104}$ different for each model due to
the computational procedures. The table includes $\gamma$ values for each model for
comparison reason.

Table: 5-4- 4 the Descriptive statistics for the estimated efficiency

<table>
<thead>
<tr>
<th>stats</th>
<th>TE (M1)</th>
<th>TE (M2a)</th>
<th>TE (M3a)</th>
<th>TE (M4)</th>
</tr>
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<tbody>
<tr>
<td>$\gamma^{105}$</td>
<td>0.7470</td>
<td>0.6818</td>
<td>0.6728</td>
<td>0.5140</td>
</tr>
<tr>
<td>mean</td>
<td>0.42</td>
<td>0.75</td>
<td>0.72</td>
<td>0.51</td>
</tr>
<tr>
<td>sd</td>
<td>0.18</td>
<td>0.18</td>
<td>0.21</td>
<td>0.19</td>
</tr>
<tr>
<td>skewness</td>
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<td>-0.60</td>
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</tr>
<tr>
<td>min</td>
<td>0.14</td>
<td>0.23</td>
<td>0.19</td>
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</tr>
<tr>
<td>max</td>
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<td>0.97</td>
<td>0.97</td>
<td>0.97</td>
</tr>
<tr>
<td>p5</td>
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<td>0.41</td>
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<td>0.21</td>
</tr>
<tr>
<td>p25</td>
<td>0.30</td>
<td>0.62</td>
<td>0.54</td>
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<tr>
<td>p50</td>
<td>0.40</td>
<td>0.83</td>
<td>0.80</td>
<td>0.51</td>
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</table>

Table: 5-4- 5 Correlation between different model specification, TE

<table>
<thead>
<tr>
<th>TE</th>
<th>tem1</th>
<th>tem2a</th>
<th>tem3a</th>
<th>tem4</th>
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</tr>
<tr>
<td>TE M2a</td>
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<tr>
<td>TE M3a</td>
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<td>0.96</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>TE M4</td>
<td>0.61</td>
<td>0.68</td>
<td>0.71</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Figure 5-4- 1 Technical Efficiency Scores Correlation Matrix

104 The computational procedures for $\gamma$ differ for each model specification (i.e. M1 and M

$\gamma = \frac{\sigma_c}{\sigma_c + \sigma_r}$

105 $\gamma$ is significant at 99% level for all models.
It is observed from the table that $\gamma$ in M1 is higher compared to all other models and it drops to the least in M4. M2a and M3a produce approximately similar value for $\gamma^*$. The estimated technical efficiency for inefficiency models (M2a, M3a) are highly correlated ($R^2= 0.96$). Furthermore there is a slight difference in the average estimated technical efficiency for both models [See table (5-4-4)].

M1 estimated technical efficiency has low levels of correlation with other alternative models technical efficiency, in particular M2a ($R^2= 0.42$), M3a ($R^2= 0.44$). In contrast M4 estimated seems to be highly correlated with all models estimated efficiency [see table (5-4-4)]. The average technical efficiency for M4 is slightly higher than the one generated by M1.

The observed discrepancy between the various models’ estimated technical efficiency is similar to Coelli, Perelman, and Romano (1999) findings. The authors argue that it is expected and permissible due to the different computational procedures of the one-sided error in each model.

Figure (5-4-2) illustrates the kernel density\(^{106}\) distribution of the technical efficiency estimated using different model specification (M1, M2a, M3a and M4). The graphs in figure (5-4-2) reveal the changes of technical efficiency distribution according to each model specification.

\(^{106}\) A kernel density plot can be regarded as a smoothed version of a histogram (silverman,1986) and directly comparable with a normal distribution The kernel density illustrated in figure(5-4-2) is obtained using the standard command for kernel density in STATA 9.1, assuming optimal width and Epanechnikov kernel function.
It is worth noting that it is difficult to compare directly the distribution from each model because of the differences in the underlying model’s structure. However, the graphs above give insight on the choice of the models specification hence M2a and M3a seems to be bimodal\(^\text{107}\) (i.e. encompasses two modes) with two peaks. This pattern could also be explained as the heterogeneity effect among the banks in the sample. M2 and M4 in contrast, tend to be unimodal, with modes 0.4, 0.5 respectively. Furthermore technical efficiency seems to be more likely normally distributed (i.e. mean=median=mode) compared to other alternative models. On the other hand, inefficiency effects models (M2a, and M3a) technical efficiency (TE) distribution seems to be skewed to the right and clearly reveal a biased pattern from normal distribution.

\(^{107}\) In case the data is distributed bimodally, the mean cannot be interpreted as the most typical value.
5.4.3. The Parametric Efficiency of the Egyptian Banks

We now turn to the preferred model from Case four. Model four, M4 is the model verified by the log likelihood ratio test to be the truly specified among other alternative models.

Table: 5-4-6 Model four “The Selected Model”

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sym</th>
<th>coeff</th>
<th>t-ratio</th>
<th>Sign level</th>
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<th>Sym</th>
<th>coeff</th>
<th>t-ratio</th>
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Hypothesis test

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<tr>
<th>Hypothesis test</th>
<th>Value</th>
<th>Sign level</th>
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<tbody>
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</tr>
<tr>
<td>H0: µ=0</td>
<td>7.96</td>
<td>*** Reject Ho</td>
</tr>
<tr>
<td>H0: µ=π=0</td>
<td>88.49</td>
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<tr>
<td>H0: γ=µ=π=0</td>
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<td>H0: ζ=ζ=ζ=ζ</td>
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<tr>
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<td>RTS=109</td>
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<td>H0: β1=β2=β3=0</td>
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<td>*** Reject Ho</td>
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<tr>
<td>H0: ββ2+β3=α</td>
<td>8.01</td>
<td>*** Reject Ho</td>
</tr>
</tbody>
</table>

108 The critical value for any test involving γ=0 is obtained from Table1 of Kodde and Palm (1986:1246).

109 Input distance function returns to scale (RTS) = −(1/∑(βm))m=1=1.41 (Fare and Primont, 1995).
In table 5-4-6 the estimated outputs’ coefficients (\( \beta_1, \beta_2, \text{and} \beta_3 \)) satisfies the monotonicity assumptions. All the outputs coefficients have a negative sign and all are significant at 99% level. The estimated coefficients for the normalised inputs variables (\( \beta_4 \text{and} \beta_5 \)) also have the expected positive sign and all are significant at 99% level. Both time trend coefficients for \( t \) and \( t^2 \) are negative and significant at levels 99% and 95% respectively, which implies technological regress over time during the sample period, however, at a decreasing rate. In contrast, the outputs second order coefficients associated with time trend (t) are all insignificant, however, the inputs second orders coefficients associated with time trend are significant for the normalised inputs X1 and X3 at 99% and 95% level respectively.

The estimated coefficient of the openk has the expected sign and significant at 99% level, however very low (0.01) suggesting that the openness of the economy would stimulate banks to improve their technology. Similarly the gdpg coefficient is very low (0.01) and has a positive sign as expected and significant at 95% level. This implies that the higher levels of economic growth would have positive impact on the Egyptian banks technology progress. This impact however is considerably low.

The coefficient of the liberalisation dummy variable (0.19) is positive as expected and significant at 99%. This shows that the liberalisation of the banking system in Egypt has a positively influenced the technological progress of the banks on average. In contrast, the privatisation variables are insignificant but with the expected positive sign. This result reflects and coincides with trends in the non-
parametric technological change in the previous section. The size matters in the Egyptian case, hence the dummy variables of large (L) and medium (M) size banks are both negative and significant at 99% level. The results postulate that small size banks (base case) seem to be more successful in technological progress in comparison to large and medium size banks.

On the other hand, most of the ownership dummy variables are statistically insignificant. While the state-owned banks ownership dummy variable has relatively high negative significant coefficient (-0.87) the private banks eventually sold to foreign ownership (P_TF) have a relatively high positive significant coefficient (0.89). In contrast the coefficient of private, joint venture (JV), joint venture sold to foreign (JV_TF) and joint venture sold to private (JV_TP) dummy variables are all statistically insignificant. It seems from the signs of the coefficients that state, private and even foreign banks (base case) have experienced technological regress during the sample period. Moreover, the state-owned banks seem to have the maximum significant technological regress.

Despite the fact that t test for the coefficients of some environmental and bank-specific variables tend to be insignificant. The LR test of whether the environmental and bank-specific variables are affecting the shape of the production technology rejects the null hypothesis that ($\zeta' = 0$) at 99% level. Moreover, $\eta$ is positive and statistically significant which imply that the Egyptian banks efficiency improves over time. The hypothesis tests of $\mu = 0$ reject the null hypothesis that the Egyptian banks inefficiency is time-invariant at 99%. The LR test of $\gamma = 0$ is also rejected at 99% level, which asserts the existence of technical
inefficiency in the sample period. The hypothesis test for returns to scale\(^{110}\) rejects the null hypothesis \((\beta_1 + \beta_2 + \beta_3 = -1)\) that the Egyptian banks exhibits constant returns to scale at 99% level\(^{111}\). The scale elasticity of the input distance function is measured by the negative inverse of the sum of the output elasticities [see Fare and Primont (1995:38-40)].

The Egyptian banks experienced increasing returns to scale (1.41) during the sample period. Figure 5-4-3 illustrates the kernel density distribution of the technical efficiency for the Egyptian banks during three sub-periods; Pre-liberalisation (1984-1990), post-liberalisation (1991-1995) and post-privatisation (1996-2002). The Kernel density distribution depicts the improvement of banks efficiency during post-liberalisation and post-privatisation periods. The Kernel

\[^{110}\text{FRONTIER 4.1 does not provide return to scale test however, it provides the variance covariance matrix from which to extract the variance covariance.}\]

\[^{111}\text{The test statistic is } t = \frac{(\beta_1 + \beta_2 + \beta_3) - \text{(hypothesized value)}}{se}, \text{ where } se = \sqrt{\text{var}_{\beta_1} + \text{var}_{\beta_2} + \text{var}_{\beta_3} + 2(\text{cov}_{\beta_1\beta_2} + \text{cov}_{\beta_2\beta_3} + \text{cov}_{\beta_3\beta_1})} \]
distribution of the technical efficiency tends to skew to the right hand-side over time, which asserts technical efficiency progress. The shift of the mean/mode to the right demonstrates the inclined number of observations at high efficiency levels. Nevertheless, the improvement in average efficiency during post-liberalisation period seems to exceed the post-privatisation improvement. The parametric results coincided with other studies findings [i.e. Zaim, (1995); Fethi et al (1998); and Isik and Hassan, (2003)] for Turkish banks; Gilbert and Wilson, (2002) for the Korean banks; Chen et al, (2005) for the Chinese banks; Leightner and Lovell, (1998) Thai banks.

The parametric estimation of technical efficiency coincides with the non-parametric results discussed in the previous section. Both methods reveal that during post liberalisation period a significant improvement is observed in the Egyptian banks’ efficiency. In addition, it is essential for the purpose of the study to further investigate the efficiency performance of different ownership and different banks size. This concern has been raised in the literature by many studies. For instance Isik and Hassan (2002) argue that the magnitude of the liberalisation impact varies among the different forms of banks’ ownership and size.

5.4.3.1. Ownership, Size and Bank’s Efficiency

Similar to the non-parametric results the parametric technical efficiency results show that state-owned banks tend to outperform other ownership rivals in terms of average efficiency during the sample period. Figure 5-4-4 illustrates that private bank transformed to foreign ownership (P_TF) are the least efficient
compared to other ownership forms. A huge efficiency gap is depicted between that particular bank and other ownership rivals. The private banks are third least efficient after JV_TP banks. This result contradicts with the theoretical debate that private owned enterprises tend to perform better than state-owned enterprises. Nevertheless, Zaim (1995) found the same results in Turkish banks.

Figure 5-4- 4 Average efficiency by ownership over the sample period

Figure (5-4-5) illustrates that during the sample period it seems that the state-owned banks sustained its superiority compared to private and foreign banks in terms of average efficiency. On the other hand, the foreign banks seems to improve its performance to catch-up with the JV and JV_TF rivals eventually, succeeded to tighten the gap between its closest rival between its nearest rival on the frontier JV_TF towards the ends of the sample period\textsuperscript{112}. Overall, it can be seen from the graph that the efficiency gap is slowly narrowing towards the end of the sample period. Similar to the present study results, Denizer et al. (2007)

\textsuperscript{112} Also see Appendix (9) table (1)
observed a stable pattern of the state-owned banks efficiency level while analysing the Turkish banks efficiency performance.

<table>
<thead>
<tr>
<th>Ownership</th>
<th>All years</th>
<th>Pre-liberalisation</th>
<th>Post-liberalisation</th>
<th>Post-privatisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>0.63</td>
<td>0.52</td>
<td>0.64</td>
<td>0.73</td>
</tr>
<tr>
<td>Private</td>
<td>0.47</td>
<td>0.33</td>
<td>0.47</td>
<td>0.6</td>
</tr>
<tr>
<td>P_TF</td>
<td>0.23</td>
<td>0.11</td>
<td>0.21</td>
<td>0.35</td>
</tr>
<tr>
<td>JV_TP</td>
<td>0.45</td>
<td>0.32</td>
<td>0.45</td>
<td>0.58</td>
</tr>
<tr>
<td>JV_TF</td>
<td>0.53</td>
<td>0.41</td>
<td>0.53</td>
<td>0.65</td>
</tr>
<tr>
<td>JV</td>
<td>0.56</td>
<td>0.43</td>
<td>0.57</td>
<td>0.68</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.51</td>
<td>0.38</td>
<td>0.52</td>
<td>0.64</td>
</tr>
<tr>
<td>Total</td>
<td>0.51</td>
<td>0.39</td>
<td>0.51</td>
<td>0.63</td>
</tr>
</tbody>
</table>

All banks experienced efficiency progress during the post-liberalisation period compared to the pre-liberalisation period. According to the average efficiency presented in table 5-4-7 the liberalisation policies did not have a reshuffling effect on banks group ranking. The ownership strata (state-owned) that were the most efficient pre-liberalisation remained the same post-liberalisation and post-privatisation periods. Similarly, other ownership strata have maintained their efficiency ranks during the all sub-periods. The P_TF bank benefited the most from liberalisation compared to other forms of ownership. The bank almost doubled its efficiency levels however remained the least efficient. This results coincide with the argument that liberalisation might affect different forms of ownership with different magnitudes.

The present study’s findings also shed lights on the discrepancies in the efficiency performance among different sizes of banks. The large banks tend to outperform medium and small banks in terms of average efficiency. The small banks’ average efficiency exceeds the medium sized banks’ average efficiency. However, the least efficient of the medium sized banks tend to be the most benefited from the
liberalisation and privatisation polices. A significant improvement of medium banks average efficiency during each period of policy change is depicted in figure 5-4-5. Demir et al. (2005) and Isik and Hassan (2005) find that in a more liberal environment the large size banks tend to perform better.

![Technical Efficiency by Size](image)

Figure 5-4-5 technical efficiency by size

For the privatisation effect, table 5-4-7 reveals that the joint-venture banks sold to foreign owners (JV_TF) performed better than banks (JV_TP) sold to domestic private investors. This performance superiority is observed before and after the privatisation period. This result supports the argument that foreign investors tend to target the best performing banks in the local markets when it comes to acquisition decisions. The private bank eventually acquired by foreign ownership (P_TF) is the least efficient among other ownership forms. Nevertheless, that particular bank seems to have benefited most from ownership transformation as well from liberalisation in terms of the growth in average efficiency.

It seems that state-owned banks tend to perform better in the Egyptian case. The liberalisation policies result in slightly narrowing the efficiency gap between the best practice banks’ group (state-owned banks) and other ownership rivals. The
results indicate that large banks are more efficient than medium and small sized banks. The magnitude of the liberalisation effect varied between different forms of ownership and different banks’ sizes. The private banks tend to have benefited most from liberalisation. The medium size banks efficiency improved the most compare to other sizes. Privatisation improved banks performance and the foreign banks tend to target the most efficient banks.

5.4.4. The Parametric Productivity of the Egyptian Banks

Measuring efficiency does not inform much about the change in performance overtime unless depicted graphically. The productivity analysis in the present section aims to investigate how productive the Egyptian banks were during the sample period. I employ the generalised Malmquist total factor productivity index (GMTFPI) proposed by Orea (2002) for this purpose. The index is decomposed to its main components namely efficiency change, technological change and scale efficiency change. This section investigates the policy implication of liberalisation and privatisation on Egyptian banks’ productivity growth. It also explores if any variation exists in the productivity growth and its components among different forms of banks’ ownership and sizes.

Model 4 parameters are used to estimate the Malmquist productivity index and further decompose it into Technical Efficiency Change (EC), Technological Change (TC) and Scale Efficiency Change (SEC) following the Orea (2002) specification. The SFA is employed in the productivity analysis and assumes that environmental and bank-specific variables affecting the shape of production technology. Previously the present study introduced comprehensive justification
for the choice of that particular model (M4). The empirical result for Model four (M4) is presented in table 5-4-4. The first order coefficients of the input distance function can be interpreted as distance elasticities evaluated at the sample mean. Hence, the inputs and outputs variables are divided by its geometric mean. Furthermore, in order to impose homogeneity in inputs the fixed asset is used as a numerator. Table 5-4-4 depicts that all the first order coefficients have the expected signs. Implying that the input distance function is decreasing in inputs and increasing in outputs at the sample mean.

Table 5-4-8 Monotonicity descriptive statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Obs</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
<th>Number of positives</th>
<th>Number of negatives</th>
<th>% of Wrong(+) sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Loans</td>
<td>475</td>
<td>-0.528</td>
<td>0.108</td>
<td>-1.155</td>
<td>-0.243</td>
<td>0</td>
<td>475</td>
<td>0.0%</td>
</tr>
<tr>
<td>Securities &amp; Investments</td>
<td>475</td>
<td>-0.074</td>
<td>0.032</td>
<td>-0.169</td>
<td>0.084</td>
<td>14</td>
<td>461</td>
<td>2.9%</td>
</tr>
<tr>
<td>Other Income</td>
<td>475</td>
<td>-0.107</td>
<td>0.073</td>
<td>-0.233</td>
<td>0.211</td>
<td>26</td>
<td>449</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

Table: 5-4-8 illustrates the descriptive statistics on the observations of the outputs elasticities and the scale elasticities (i.e. sum of output elasticities). The statistics reveal that monotonicity holds for each observation for total loan. In contrast, it fails in 3% and 5.5% of securities and investment and other income respectively. Since the last two outputs elasticities represents roughly 25 percent of total elasticities it can be surmised that the effect of economies of scale on productivity growth is on average accurately measured (Orea, 2002:16-17).

The last row in table 5-4-8 provides the scale elasticity of the input distance function as the negative inverse of the sum of the output elasticities following

\[
\text{RTS} = \frac{1}{\sum_{m=1}^{3} \beta_m} = \frac{1}{0.708} = 1.445
\]

\[
\text{RTS} = \frac{1}{(1/\sum_{m=1}^{3} \beta_m)} = \frac{1}{0.909} = 1.012
\]
Fare and Primont (1995:38-40). The geometric mean of this sum is 1.44 and is significantly different from one, indicates the presence of immoderate increasing return to scale - a result observed in many previous banking studies (Orea, 2002).

The CBE compelled that most of the banks to increase their paid-up capital to meet the new capital requirements limits. This could explain the rather significant increasing return to scale. Further evaluation of the scale elasticity at every data point reveals that all banks in the sample are operating with increasing returns to scale. This result contradicts the non-parametric results which suggest that Egyptian banks were working under increasing return to scale.

Figure (5-4-6) illustrates the estimated Malmquist total factor productivity index (GMTFPI). The index decomposition to technical efficiency change index (TECI), technological change index (TCI) and Scale efficiency change index (SECI). The
Egyptian banks experience 30% average productivity growth during the sample period. Productivity growth is attributable mainly to the rather significant growth in scale efficiency of 29%. They experienced regress in the technology of -4% during the sample period. The technical efficiency change is 5% on average during the sample period. Efficiency change and the negative technological change on average seem to adopt a downward pattern over the sample year\textsuperscript{113}. The scale efficiency change offset the TCI and TECI trends adopting an upward trend, which in turn stimulates the upward trend of the productivity growth.

The banks expanded in financial intermediation in the output side\textsuperscript{114} compared to the input side (the frontier enlarged) during the sample period. Simultaneously, production technology was shifting inward implying technical regress. However the efficiency of the Egyptian banks improves over time - the efficiency change trend seems exhausted towards the end of the sample period and increasing at diminishing rate. The reform policies embarked by the government played a vital role in stimulating the economic growth overall and particularly the banking sector. The expansion in privatisation and the enhancement of the capital market laws in early 1990s have stimulated both direct and indirect investment and positioned Egypt as an important investment destination in the region. The new investment projects required support from banks in terms of lending facilities. This could explain the immense scale efficiency progress. The reduction in the reserve requirement as part of the liberalisation programmes by the regulator freed more cash to the banks to expand in investing and granting loans. The banks

\textsuperscript{113} For more details see Appendix (9) table (2)

\textsuperscript{114} The scale efficiency catch-up (SECI) and the pure technical efficiency catch-up (PECI) are orientation dependent. The scale size is measured in inputs when adopting an output orientation whereas when adopting the input orientation the (present study case) the scale size is measured on the outputs (Thanassoulis, 2001).
response to competition is positive and reflected in efficiency improvement. The inward shift in technology however, is not expected. Hence, many domestic banks invested in new information technology systems (ITS) to compete with the foreign banks.

Nevertheless, the technical change is not necessarily attributable to improvement in the means of production technology (innovation). Regulations, organisational structural, input prices, and input quantities also affect the technical change (Forsund, 1993). Isik et al (2002) find post-liberalisation technical regress, in the case of the Turkish banks despite investment in technology by the banks. The author explained that the Turkish banks are learning by doing. Similarly, the same explanation can be applied to the Egyptian banks.

5.4.4.1. Ownership, Size, and Bank’s Productivity

The study investigates whether various forms of ownership and sizes would response differently to changes in government policies. Table 5-4-10 summarises GMTFPI and its component TEI, TCI and SECI in index form for each ownership group over three sub-periods. In general overall sample period the state-owned bank outperformed the other forms of ownership in productivity growth GMTPI (1.49).

<table>
<thead>
<tr>
<th>Ownership</th>
<th>TECI</th>
<th>TCI</th>
<th>SECI</th>
<th>GMTFPI</th>
<th>GMTP%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

115 The geometric mean of the generalised Malmquist productivity index and its decomposed indexes is calculated.

116 Value <1 means regress, value >1 means progress
<table>
<thead>
<tr>
<th></th>
<th>State</th>
<th>Private</th>
<th>P_TF</th>
<th>JV_TP</th>
<th>JV_TF</th>
<th>JV</th>
<th>Foreign</th>
<th>All Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.03</td>
<td>0.97</td>
<td>1.49</td>
<td>1.49</td>
<td>0.97</td>
<td>1.38</td>
<td>0.96</td>
<td>1.05</td>
</tr>
<tr>
<td>Overall</td>
<td>1.03</td>
<td>0.97</td>
<td>1.49</td>
<td>1.49</td>
<td>0.97</td>
<td>1.38</td>
<td>0.96</td>
<td>1.05</td>
</tr>
<tr>
<td>Pre-liberalisation</td>
<td>State</td>
<td>1.04</td>
<td>0.99</td>
<td>1.47</td>
<td>1.52</td>
<td>0.99</td>
<td>1.32</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
<td>1.08</td>
<td>0.97</td>
<td>1.30</td>
<td>1.36</td>
<td>0.97</td>
<td>1.32</td>
<td>0.97</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>1.16</td>
<td>0.91</td>
<td>1.53</td>
<td>1.62</td>
<td>0.91</td>
<td>1.53</td>
<td>0.97</td>
<td>1.07</td>
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<td>1.37</td>
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<td>1.30</td>
<td>0.98</td>
<td>1.06</td>
</tr>
<tr>
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<td>0.97</td>
<td>1.28</td>
<td>1.33</td>
<td>0.97</td>
<td>1.28</td>
<td>0.98</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>1.06</td>
<td>0.98</td>
<td>1.18</td>
<td>1.24</td>
<td>0.98</td>
<td>1.18</td>
<td>0.98</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>1.07</td>
<td>0.97</td>
<td>1.32</td>
<td>1.38</td>
<td>0.97</td>
<td>1.32</td>
<td>0.97</td>
<td>1.07</td>
</tr>
<tr>
<td>Post-liberalisation</td>
<td>State</td>
<td>1.03</td>
<td>0.97</td>
<td>1.53</td>
<td>1.53</td>
<td>0.97</td>
<td>1.32</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
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<td>1.27</td>
<td>1.27</td>
<td>0.95</td>
<td>1.27</td>
<td>0.95</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>1.12</td>
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<td>0.96</td>
<td>1.28</td>
<td>0.96</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>1.06</td>
<td>0.96</td>
<td>1.31</td>
<td>1.33</td>
<td>0.96</td>
<td>1.31</td>
<td>0.96</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>1.05</td>
<td>0.96</td>
<td>1.25</td>
<td>1.25</td>
<td>0.96</td>
<td>1.25</td>
<td>0.96</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
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<td>0.96</td>
<td>1.25</td>
<td>1.26</td>
<td>0.96</td>
<td>1.25</td>
<td>0.96</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>1.04</td>
<td>0.96</td>
<td>1.31</td>
<td>1.32</td>
<td>0.96</td>
<td>1.31</td>
<td>0.96</td>
<td>1.04</td>
</tr>
<tr>
<td>All Banks</td>
<td>1.05</td>
<td>0.96</td>
<td>1.31</td>
<td>1.32</td>
<td>0.96</td>
<td>1.31</td>
<td>0.96</td>
<td>1.04</td>
</tr>
<tr>
<td>Post-privatisation</td>
<td>State</td>
<td>1.02</td>
<td>0.96</td>
<td>1.47</td>
<td>1.44</td>
<td>0.96</td>
<td>1.32</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>1.04</td>
<td>0.94</td>
<td>1.35</td>
<td>1.31</td>
<td>0.94</td>
<td>1.35</td>
<td>0.94</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>1.07</td>
<td>0.94</td>
<td>1.35</td>
<td>1.37</td>
<td>0.94</td>
<td>1.35</td>
<td>0.94</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>1.04</td>
<td>0.94</td>
<td>1.39</td>
<td>1.36</td>
<td>0.94</td>
<td>1.39</td>
<td>0.94</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>1.03</td>
<td>0.94</td>
<td>1.34</td>
<td>1.30</td>
<td>0.94</td>
<td>1.34</td>
<td>0.94</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>1.03</td>
<td>0.94</td>
<td>1.43</td>
<td>1.37</td>
<td>0.94</td>
<td>1.43</td>
<td>0.94</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>1.03</td>
<td>0.94</td>
<td>1.29</td>
<td>1.26</td>
<td>0.94</td>
<td>1.29</td>
<td>0.94</td>
<td>1.03</td>
</tr>
<tr>
<td>All Banks</td>
<td>1.03</td>
<td>0.94</td>
<td>1.37</td>
<td>1.34</td>
<td>0.94</td>
<td>1.37</td>
<td>0.94</td>
<td>1.03</td>
</tr>
</tbody>
</table>

The main driver of growth in the state-owned bank is the rather immense scale growth compared to others (SEI=1.49). This result reflects a prominent characteristic of the Egyptian banking sector as a segmented market. Hence, the big four banks (state-owned banks) hold 70% of the deposits and loans of the whole sector. This privilege seems to have enabled the banks to attain such huge growth in productivity. Another reason which might have further facilitated growth in state-owned banks was that they lack strong rules of corporate
governance and risk management compared to private and foreign banks. Hence unlike private and foreign-owned rivals the state-owned banks seem to be involved in many cases of directed credit. This is not necessarily for state-owned companies but also for high net-worth private sector entrepreneurs who have certain levels of political exposure.

Private banks with 1.31 outperform the foreign banks in terms of productivity growth, with 1.24. The foreign banks are the least productive compared to other ownership rivals. The P_TF bank with 1.45 comes second in terms of productivity growth after the state-owned banks. The JV, JV_TP and JV_TF achieved productivity growth of 1.37, 1.35 and 1.30 respectively. The impressive scale efficiency progress and moderate efficiency progress are the main drivers of productivity all ownership experiences inward shifts in production technology. The most impressive catch-up by P_TF bank is 1.11 and the least by the state-owned banks is 1.03. The state-owned banks have the least inward shift in technology (0.97) compared to other ownership rivals.

In terms of size, it is plainly foreseeable that large banks outperformed both medium and small size banks in terms of productivity growth. The productivity growth for large, medium and small size banks are 34%, 28%, and 26% respectively. Most of the large banks are state-owned banks. The large banks achieve the least technological regress of 0.97 and the highest scale efficiency progress is 1.39 compared to the small and medium size ones (see table 5-4-10). Medium and small banks experienced the same level of inward technological shift
with 0.95 however, the medium size banks seem to have better efforts to catch up compared to large and small size banks.

Table: 5-4- 10 Generalised Malmquist Total Factor Productivity Index by bank size

<table>
<thead>
<tr>
<th>Size</th>
<th>TECI</th>
<th>TCI</th>
<th>SECI</th>
<th>GMTFPI</th>
<th>GMTP%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1.04</td>
<td>0.97</td>
<td>1.39</td>
<td>1.40</td>
<td>34%</td>
</tr>
<tr>
<td>M</td>
<td>1.06</td>
<td>0.95</td>
<td>1.31</td>
<td>1.32</td>
<td>28%</td>
</tr>
<tr>
<td>S</td>
<td>1.05</td>
<td>0.95</td>
<td>1.30</td>
<td>1.30</td>
<td>26%</td>
</tr>
<tr>
<td>All Banks</td>
<td>1.05</td>
<td>0.96</td>
<td>1.34</td>
<td>1.35</td>
<td>30%</td>
</tr>
<tr>
<td>Pre-liberalisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1.06</td>
<td>0.98</td>
<td>1.37</td>
<td>1.43</td>
<td>36%</td>
</tr>
<tr>
<td>M</td>
<td>1.08</td>
<td>0.97</td>
<td>1.29</td>
<td>1.35</td>
<td>30%</td>
</tr>
<tr>
<td>S</td>
<td>1.07</td>
<td>0.97</td>
<td>1.30</td>
<td>1.35</td>
<td>30%</td>
</tr>
<tr>
<td>All Banks</td>
<td>1.07</td>
<td>0.97</td>
<td>1.32</td>
<td>1.38</td>
<td>32%</td>
</tr>
<tr>
<td>Post-liberalisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1.05</td>
<td>0.97</td>
<td>1.38</td>
<td>1.40</td>
<td>33%</td>
</tr>
<tr>
<td>M</td>
<td>1.06</td>
<td>0.96</td>
<td>1.27</td>
<td>1.29</td>
<td>25%</td>
</tr>
<tr>
<td>S</td>
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<td>0.96</td>
<td>1.25</td>
<td>1.26</td>
<td>23%</td>
</tr>
<tr>
<td>All Banks</td>
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<td>0.96</td>
<td>1.31</td>
<td>1.32</td>
<td>28%</td>
</tr>
<tr>
<td>Post-privatisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1.03</td>
<td>0.95</td>
<td>1.42</td>
<td>1.39</td>
<td>33%</td>
</tr>
<tr>
<td>M</td>
<td>1.04</td>
<td>0.94</td>
<td>1.36</td>
<td>1.33</td>
<td>28%</td>
</tr>
<tr>
<td>S</td>
<td>1.03</td>
<td>0.94</td>
<td>1.33</td>
<td>1.29</td>
<td>26%</td>
</tr>
<tr>
<td>All Banks</td>
<td>1.03</td>
<td>0.94</td>
<td>1.37</td>
<td>1.34</td>
<td>29%</td>
</tr>
</tbody>
</table>

5.4.4.2. Policy implication and productivity growth

During the pre-liberalisation period, the state-owned banks in Egypt dominated the banking sector in terms of deposits and loans. Figure 5-4-7117 depicts the insignificant improvement in state-owned banks post-liberalisation of 43% compared to pre-liberalisation of 42% period. The sustainable growth rate in productivity witnessed in the state-owned banks arose mainly from the impressive scale efficiency growth. The state-owned banks played an important role during

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117 The graph key; I) each bubble colour belongs to one of the ownership cluster (1st –D) [see graph legend]. II) The position of each bubble in the graph is according to the coordinates of X-axes SECI (2nd –D) and Y-axes TCI (3rd –D). III) The size of the bubble is representing the TECI (4th –D). IV) The values adjacent to each bubble represent % change in GMTFP (5th –D). IV) The colours of the bubble’s outline and productivity growth value represents each sub-periods orange colour (pre-liberalisation), green colour (post-liberalisation), and illuminate light blue (post-privatisation) (6th –D).
that period in financing many economic activities. These banks have a competitive advantage of being able to mobilise deposits easier than other ownership rivals. This gave them the edge compared to other rivals to expand lending particularly to large projects.

![Figure 5-4- 7 GMTFPI and its components by bank group](image)

The foreign banks appeared to get maximum benefit during the liberalisation period. During liberalisation, the productivity growth for the foreign banks is 23% compared to 21% pre-liberalisation. Their productivity growth is attributable to significant increase in scale efficiency. Except the state-owned and foreign banks other ownership groups experienced regress in post-liberalisation productivity growth compared to pre-liberalisation. The regress in productivity in these banks stems from relatively low growth scale efficiency change compared to the pre-liberalisation period. The P_TF bank was the only bank that

---

118 This is due to the cultural aspect that household trust the state-banks.
experienced the least technological change during post-liberalisation compared to the pre-liberalisation period. The slightly diminishing growth in technical efficiency change in all banks can be depicted in the graph in faint contraction of the bubble size for each bank group.

Privatisation seems to improve the productivity of the privatised banks. The JV_TP and JV_TF banks experienced productivity growth post-privatisation of 31%, 26% compared to 28%, 23% respectively. Their growth stemmed mainly from improvements in scale efficiency change. Foreign and P_TF banks productivity growth remained the same 23%, 31% respectively during post-liberalisation and post-privatisation periods. Private banks productivity growth during post-privatisation periods is 27% compared to 23% post-liberalisation. In contrast the state-owned banks productivity growth decrease mainly due to diminishing scale efficiency growth.

It seems that further implementation of reform policies stimulated competition and improved the contribution of other ownership banks in financial intermediation. The dominance of state-owned banks still exists. However, other bank ownership groups seem to acquire more market share from the state-owned banks in more liberal environment. This gradually diminished the dominance of the state-owned banks.
5.5. Conclusion

This chapter has assessed the performance of Egyptian banks during a period characterised by change in economic environment. The Egyptian government embarked the Economic Reform and Structural Adjustment Programme (ERSAP) in the year 1991. Under the provision of ERSAP, banking sector liberalisation was part of major governmental agenda of financial sector reform. In the year 1995 the Egyptian government started a gradual privatisation of the joint-venture banks as a continuity of the liberalisation policies. The gradual approach adopted by the Egyptian government in liberalising the financial sector and particularly the banking sector is considered successful to a certain extent.

The Egyptian banking sector did not experience any financial crisis, bank failure or moral hazard. The manner of which the Egyptian government presumed in implementing the liberalisation policies were subject to applause from various policy monitors and academic researchers. Nevertheless, the Egyptian government has been criticised for the same particular reason hence it seems gradualism and cautiousness seems to have rather drifted to a slowing down and relaxed approach in implementing the liberalisation policies (Aresties, 2000 and Caprio and Cull 2000).

This study employed two prominent methodologies in the literature namely the DEA and SFA. The environmental variables influence the shape of the production technology. The SFA approach employed by the present study is most likely the first to investigate the impact of the environmental variables on the shape of bank’s production technology (Coelli, Perelman and, Romano 1999). The non-
parametric results show that liberalisation policies had a positive impact on the banks performance. The efficiency levels have improved post-liberalisation performance compared to pre-liberalisation period. Likewise, liberalisation reforms improved the productivity growth of the Egyptian banks overall.

The improvement in productivity stemmed from significant improvement in technical efficiency. Unlike the non-parametric method, the parametric results measures the scale efficiency based on variable return to scale technology. The parametric results reveal huge scale efficiency growth during the sample period in all forms of banks. The state-owned banks are the most efficient and productivity compared to other rivals. However, in more liberal environment foreign banks and privatised banks seem to acquire more market share from the state-owned banks. The foreign and JV privatised banks seem to be more scale efficient compare to other rival particularly post-privatisation period (i.e. second stage of reform).

The large banks are the most efficient and most productive compared to medium and small size banks. Regarding technical efficiency the parametric results assert the results obtained from the non-parametric. However the parametric method provides lower average of efficiency scores compared to the non-parametric. The productivity measures tend to be different between the parametric and non-parametric methods. The reasons are the differences in the underlying assumptions in both models.
6. Chapter six: Post-Liberalisation Period: Crisis and Stabilisation: The Efficiency and Productivity of Turkish banks

6.1. Introduction:

This chapter examines the performance of Turkish banks during the post-liberalisation period (1991-2000)\(^{119}\). The sample period encompasses the occurrence of two inauspicious financial shocks in Turkey. In 1994 the inflation crisis emerged in Turkey due to government expansion in high interest rate short-term credit to finance the fiscal deficit. This happened despite the new regulations with respect to capital adequacy and risk management and the introduction of the new regulatory body, the Board of Bank Regulation and Supervision (BRSA). The banks kept facing difficulties in borrowing from abroad because of the unreliable high inflationary economy; the high public deficit; and the deteriorating current account deficit.

Moreover, the IMF postponed the release of a pre-promised credit in October 2000. As a result, foreign investors lost confidence in the government and a speculative wave of TL sell-off caused financial panic represented in huge capital outflow, low levels of liquidity in the banking sector and interest rate soared to

\(^{119}\) The limitation of the data set is due to the change in accounting standards (adjustment for inflation) in the financial statement of the Turkish banks. Worth noting that till the commence of the present study the TBB did not provide a retrospective adjusted financial statements thus, the latest years could be taken into the consideration for the present study.
100%. The above-mentioned circumstances triggered the crises in the sample period in November 2000.

This chapter measures the efficiency and productivity of Turkish banks during a period characterised with financial turbulence due to the lack of gradualism and the high speed of implementation of liberalisation policies. Nevertheless the reform seemed to have successfully achieved its aims and fostered efficiency and productivity among the banks throughout the 1980s. The reduction of both work force and number of branches had a significant impact on cost reduction and consequently improving the efficiency and productivity (Isik and Hassan, 2003) and (Zaim, 1995).

The sample of Turkish banks encompasses twenty-seven\textsuperscript{120} Turkish commercial banks during the period (1991-2000). The banks are classified into two different strata, according to their ownership clusters namely state-owned, foreign, private, and SDIF banks. The size clusters\textsuperscript{121} are large, medium and small. In addition the sample period is divided into three sub-periods pre-crisis (i.e. 1990-1993), crisis years (1994 and 1995), and post-crisis or stabilisation (1996-2000). This approach will shed light on discrepancies of the performance of the whole sample banks as well as banks group (i.e. ownership and size groups) during each sub-period.

Efficiency and productivity are estimated employing both non-parametric and parametric methodologies on sample data. The production approach is applied

\textsuperscript{120}The 27 banks of which 4 major state-owned banks, 14 private banks 2 foreign banks, and 7 SDIF banks
\textsuperscript{121}The criteria of size cluster are explained in chapter four.
using the input oriented distance function to estimate both the parametric and non-parametric efficiency (i.e. technical efficiency) and productivity measures. The inputs are, fixed assets and general and administrative expenses. The outputs are total deposits total loans, and other income. Similar to the previous chapter five, a comparison between the results from both DEA and SFA methodologies are presented in chapter seven.

The chapter is organised as follows. The first section provides analytical discussion on the sample data descriptive statistics and the adopted approach for inputs and outputs specification. The second section discusses and empirical results of the non-parametric estimation and compares the efficiency and productivity of the banks during the pre- and post-crisis periods. The third section introduces the empirical results of the parametric estimation and compares the efficiency and productivity of the Turkish banks pre- and post-crisis periods. The fourth section aims to compare the results from both estimations (non-parametric and parametric) to further inspect whether there is any discrepancy/consistency between the results obtained under each methodology. Finally, the empirical findings are summarised in the conclusion part.

6.2. Descriptive Statistics:

According to the classification of Banks Association of Turkey (TBB) in the year 2000, the Turkish banking sector\textsuperscript{122} is composed of eighty (80) banks of which forty-eight (48) are commercial banks and thirty-two (32) are specialised banks.

\textsuperscript{122} For more details see Appendix (10) table (1)
The commercial banks from which our sample is chosen can be sub-grouped into four (4) state-owned banks, twenty-nine (29) private banks, five (5) foreign bank and ten (10) banks under the Savings and Deposits Insurance Fund (SDIF). This study focuses on the performance of twenty-seven (27) commercial banks, which represent almost 56% of the total number of the commercial banks in Turkey. However, in terms of total deposits and loans on average during the sample period, the sample banks represent approximately between 70% and 86% of the commercial banks industry.

Table 6-2-1 presents the number of banks in the sample relative to the commercial banks industry. The average percentage of deposits and loans relative to the industry of each bank group in the sample is also included to reveal the

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Industry No. Of banks</th>
<th>Sample/industry</th>
<th>Sample/industry</th>
<th>Sample/industry</th>
<th>Sample/industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>4</td>
<td>4</td>
<td>100.0%</td>
<td>26.0%</td>
<td>41.5%</td>
</tr>
<tr>
<td>Private</td>
<td>29</td>
<td>14</td>
<td>48.3%</td>
<td>28.8%</td>
<td>29.2%</td>
</tr>
<tr>
<td>Foreign</td>
<td>5</td>
<td>2</td>
<td>40.0%</td>
<td>1.1%</td>
<td>1.2%</td>
</tr>
<tr>
<td>SDIF</td>
<td>10</td>
<td>7</td>
<td>70.0%</td>
<td>13.7%</td>
<td>14.4%</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>27</td>
<td>56.3%</td>
<td>69.6%</td>
<td>86.3%</td>
</tr>
</tbody>
</table>

Source: The Banks Association of Turkey (TTB)

This chapter focuses on measuring bank performance in the post-liberalisation period (i.e.1990-2000). The period encompasses a variety of events, i.e. the 1994 financial crisis and the stabilisation programme imposed by the Turkish government, the IMF and World Bank to restore stability of the financial system and to the banking sector in particular.

Table 6-2-1 presents the number of banks in the sample relative to the commercial banks industry. The average percentage of deposits and loans relative to the industry of each bank group in the sample is also included to reveal the

\[ \text{Intermediation} = \frac{T.\text{Loans}}{T.\text{Deposits}} \]
relative importance of the sample banks compared to the population of the commercial banks industry. The intermediation ratio (loans/deposits) is presented in the same table to give more insight on the intermediation activity of the whole sample overall and each bank ownership category in particular.

Figure 6-2-1 provides more insights on the attitude of banks in terms of financial intermediation during the sample period. The thick black line represents the intermediation ratio for the whole industry. It seems that all bank ownership groups experienced disintermediation during the sample period. The declining pattern of all industry intermediation ratio implies that banks were reluctant to expand in financial intermediation during the problematic crisis and post-crisis periods.

![Intermediation (loans/deposits) by Ownership](image)

**Figure: 6-2-1 Intermediation ratio for the industry, sample and ownership groups**

A significant drop in the intermediation ratio appears to happen initially in the financial crisis year (1994). After the relative stabilised pattern of the intermediation ratio during the period (1995-1997) a rather declining trend is observed in the post 1997. The graph depicts that the sample banks’
intermediation levels tend to be lower than the industry intermediation levels. The average intermediation ratio for the industry is (64.7%) whereas the average efficiency levels for the sample is (52.5%) during the whole period.

The drop in intermediation ratio stemmed from fluctuated growth in both total loans and total deposits. During the sample period the average growth in loans was 10% for both sample and the industry. On the other hand, the average growth in total deposits was 14.7% and 14.2% for the sample and the industry respectively. The discussion above aims to shed more light on the situation of the Turkish banking industry during that particular period of financial unrest. The Turkish banks seemed to be less involved in intermediation activities (i.e. collecting deposits and pass it through to borrowers via loans). This behaviour is understandable as during this particular period (1990-2000) there were high default risk due to instability in the economy overall which eventually caused “moral hazard”.

Damar (2004) explains that in the late 1990s banks became more dependent on government borrowing. Hence, it was difficult for the government to raise funds on the international debt market therefore it turned to private commercial banks, which in turns borrowed the money abroad and were content to pass it through to the government to enjoy the high yield treasury bonds or bills.

The initial results of SFA estimates of banks’ technical efficiency adopting the intermediation approach produced unfavourable monotonicity signals.

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124 See Appendix (10) table (1) for more detailed comparison.
125 Interest rate reaches to 143%.
126 This is one of the advantages of using two methodologies. Hence the parametric SFA method allows for significance test for both the parameters and model fitness.
Thereupon the intermediation approach was discarded. Alternatively when the total deposits were included as output the models seemed to fit and the monotonicity test is statistically satisfactory.

I posit that during this particular period Turkish banks focused more on the basic production theory function. In other words, the Turkish banks gave little attention to the intermediation function of banks and rather focused on producing both loans and deposits to be able to sustain operations during a period characterised by financial turmoil. El-Gamal and Inanoglu (2005) clarified that during the mid 1990s the Turkish banking industry were in disintermediation mode.

Altunbas et al (2002) clarify that the substantial effects imposed by the changes in the surrounding environment particularly in the Western European area, such as liberalisation, deregulation, technological progress and internationalisation caused a major concern to the banks on what to produce. The banks might be forced to reconsider its product mix therefore the appropriateness of each method (i.e. production, intermediation and value added approaches) varies according to each circumstances (Tortosa-Ausina, 2002). Hughes and Mester (2008) emphasis that the essence of bank production is to ameliorate information asymmetries between borrowers and lenders and the ability to manage the risk associated with operations.

Consequently, it seems illogical to measure the performance of Turkish banks during the sample period assuming the intermediation function. The sample

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127 Negative signs for the total deposits variable (output) which is not consistent with the underlying assumption of the model.
period data reveals low activities in financial intermediation. Given the banking sector circumstances and the economic environment during the years 1990-2000, it seems that bank managers’ choice method to survive the financial instability was to mobilise funds (i.e. deposits\textsuperscript{128}) in order to ameliorate adverse selection and moral hazard problems.

The present study uses the production approach instead of the intermediation approach in analysing the performance of the Turkish commercial banks given the aforementioned argument and the availability of data. The outputs considered in both parametric and non-parametric estimation are total deposits, total loans and other income. The inputs are fixed assets and general and administrative expenses. There are twenty-seven banks including four state-owned banks, fourteen private banks, seven banks under SDIF and two foreign banks. The sample period is from 1990 till 2000.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Deposits</td>
<td>270.00</td>
<td>1822.62</td>
<td>2693.35</td>
<td>3.00</td>
<td>18898.00</td>
</tr>
<tr>
<td>Total Loans</td>
<td>270.00</td>
<td>891.45</td>
<td>1287.68</td>
<td>1.00</td>
<td>8581.00</td>
</tr>
<tr>
<td>Other Income</td>
<td>270.00</td>
<td>369.86</td>
<td>132.27</td>
<td>0.00</td>
<td>1256.00</td>
</tr>
<tr>
<td>General and Admin Exp.</td>
<td>270.00</td>
<td>142.65</td>
<td>189.11</td>
<td>4.00</td>
<td>1193.00</td>
</tr>
<tr>
<td>Fixed Assets</td>
<td>270.00</td>
<td>122.91</td>
<td>267.46</td>
<td>1.00</td>
<td>1890.00</td>
</tr>
</tbody>
</table>

Table (6-2-2) demonstrates high levels of dispersion (i.e. standard deviation) for all variables. The dispersion observed in the sample variables is expected given the high volatility in banks accounts during the sample period. The significant dispersion among the banks in the data set in terms of the levels of inputs and

\textsuperscript{128} Average growth in deposits during 1990-2000 14.2\% and 14.7\% versus 10.1\% and 10\% growth in loans for the industry and sample respectively [see Appendix (10) table (1)]
outputs variables might affect non-parametric results more than the parametric results. The non-parametric methodology is highly sensitive to outliers. It is highly likely to find high level of dispersion in the non-parametric results as well. For analysis purpose the chapter reports the estimated efficiency and productivity for all sample period and the three sub-periods; namely, pre-crisis (1990-1993), initial crisis years (1994 & 1995) and post-crisis years (1996-2000).

The sample banks are made of four ownership categories; state-owned, private, SDIF and foreign banks. The SDIF banks’ group\textsuperscript{129} includes two banks that were originally state-owned then privatised but failed and consequently turned into the SDIF. The other five banks in the same category were originally privately owned. Therefore, the banks ownership groups are state-owned, private, S_P_SDIF (state-owned to private then SDIF), P_SDIF (private banks turned to SDIF) and finally foreign banks.

\textsuperscript{129} The sample contains seven (7) SDIF banks.
6.3. The Non-parametric Empirical Results

6.3.1. The Efficiency of the Turkish Banks

Table 6-3-1 illustrates the non-parametric estimation of the Turkish banks’ efficiency during the overall sample period as well as the three sub-periods. The sample period average variable return to scale efficiency (VRS eff) is 0.75 on the other hand the constant return to scale (CRS eff) and scale efficiency are 0.58 and 0.76 respectively. The average efficiency levels of the sample banks slightly improved during the crisis period (VRS eff) 0.82 compared to pre-crisis efficiency (VRS eff) 0.80.

In the post-crisis period however, a significant decline in average efficiency occurred with a (VRS eff) of 0.75. Moreover, these non-parametric results postulate that on average during the sample period, 56% of the sample banks exhibited decreasing returns to scale.\(^{133}\) This ratio decreased to its lowest level of 41% in 1998 and soared to its maximum level of 85% in 1993, just one year

<table>
<thead>
<tr>
<th>Period</th>
<th>CRS(^{130})</th>
<th>VRS(^{131})</th>
<th>Scale Eff(^{132})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>0.58</td>
<td>0.75</td>
<td>0.76</td>
</tr>
<tr>
<td>Pre-crisis</td>
<td>0.53</td>
<td>0.80</td>
<td>0.65</td>
</tr>
<tr>
<td>Crisis</td>
<td>0.69</td>
<td>0.82</td>
<td>0.84</td>
</tr>
<tr>
<td>Post-crisis</td>
<td>0.57</td>
<td>0.70</td>
<td>0.80</td>
</tr>
</tbody>
</table>

\(^{130}\) Input oriented efficiency scores assuming CRS \(L(\theta_1|C,s) = \theta_1L(y|C,s), \theta > 0, \lambda \geq 0\)

\(^{131}\) Input oriented efficiency score assuming VRS \(L(\theta_1|V',s) = \theta_1L(y|V',s), \theta > 0, \lambda \geq 1\)

\(^{132}\) Scale Efficiency \(S(y,x|S) = F(y,x|C,s) / F(y,x|V',s)\)

\(^{133}\) For more details see Appendix (11) table (1)
before the crisis. It seems that most of the banks during the sample period were operating below the optimum scale levels. This is due to the financial instability during the period, which arguably could have double effects on the banks performance. First, the instability in the financial sector might lead to high levels of non-performing loans and consequently deter banks efforts to increase loans either because they are reluctant to increase the loans portfolio or their outstanding loan portfolio encompasses relatively high levels of non-performing loans. Second, during the period of crisis the Turkish banks suffered from creditability in addition to the high inflation rates during the period. Such circumstances would force the households to seek alternative safer instruments for investment. El-Gamal and Inanoglu (2005) clarified that during the sample period the Turkish households were hoarding roughly US$ 15 billion in cash and gold, hence, the later as inflation-hedge.

It is worth noting that the discussion of the efficiency levels hereafter focuses on the VRS efficiency rather than CRS efficiency. The SFA (IDF) is a curved productivity function similar to DEA-VRS where economies of scale are not considered to be relevant for efficiency (C.von Hirschhausen, 2006). Therefore, it would be appropriate to focus on DEA VRS for comparison reasons. The next section of the present chapter is discussing the SFA translog input distance function (IDF) estimated efficiency at a greater length.

Figure 6-3-1 depicts significant decrease in average efficiency after 1994. It seems that the failure of the stabilisation program suggested by IMF and implemented by the Turkish government to decrease the inflation and stabilise the
financial sector is reflected on the banks efficiency. This suggests that the focus of the Turkish banks was to invest in government policies rather than producing loans and deposits. It is worth noting that during that particular period there were fifteen banks with poor financial position. (Soral et al., 2006). Nevertheless, the government was unwilling to close these banks because of the consequences of liquidating them. In effect, these banks became dependent on the government borrowing, as it was difficult for the government to raise funds on the international debt market thus, it turned to private commercial banks which in turns borrowed the money abroad and were content to pass it through to the government to enjoy the high yield treasuries bonds or bills (Damar, 2004).

Figure: 6-3- 1 Turkish banks average CRS, VRS and scale efficiency

The empirical results of the present study coincide with Ozkan –Gunay and Tektas (2006). In their study they observed regress in efficiency levels during the late 1990s. The authors explained that the crises had a significant impact on the deteriorating efficiency of the banks within the sample. In contrast, Yildirim

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134 Interest rate reach 143%
135 Ozkan-Gunay and Tektas(2006) employed DEA to investigate the Turkish banks performance during the period 1990-2000
(2002) asserts that there was no decline in both technical and scale efficiency during the period. Nevertheless, she reported immense variation in both pure technical and scale efficiency measures with no significant evidence of sustainable efficiency gains. Furthermore, her results reveal that the decline in scale efficiency was prominent hence, the banks suffered from decreasing return to scale.

6.3.1.1. Ownership, Size, Privatisation and Banks’ Efficiency:

The previous discussion revealed that in the post-liberalisation period both technical and scale efficiency seems to adopt volatile pattern implying instability in banks performance during the sample period. The average technical and scale efficiency declined dramatically during the financial crisis period despite the government immense efforts to stabilise the financial sector. Most of the sample banks failed to operate on the optimum scale.

Figure: 6-3-2 Technical Efficiency by Ownership group

136 Yildirim (2002) use DEA to investigate Turkish banks performance during the period 1988-1999
Button and Weyman-Jones (1992), Isik et al. (2002) and Isik and Hassan (2003a,b) suggested that different forms of ownership and size might have altered response to liberalisation policies. The current section investigates efficiency between various banks groups in terms of ownership and size.

The patterns of average efficiency per ownership groups illustrated in figure 6-3-2 reflect the situation of the banking sector during sample period. The results coincide with previous studies, which also find decline in efficiency during the late 1990s that offset the efficiency gains obtained during the liberalisation period. The results also show that all types of ownership experienced decline in technical efficiency. State-owned banks seem to be the least affected in the crisis with rather volatile pattern of average efficiency. The poor performance of the privatised state-owned banks was matched by the SDIF (S_P_SDIF)\(^ {137}\). The originally privatised state-owned banks seemed to be the least efficient with sharp decline in efficiency score particularly post-the 1994 crisis. Surprisingly the S_P_SDIF began the sample period with rather strong performance, but this soon deteriorated and sharply diverged away from efficiency frontier.

Further investigation on the performance of these two particular S_P_SDIF banks namely Sumerbank and Etibank reveal astounding results. The two banks experience drop in efficiency levels initially post-privatisation. The declining trend in efficiency of these two particular banks continued till the end of the sample period.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sumerbank</th>
<th>Etibank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1992</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1993</td>
<td>0.75</td>
<td>1</td>
</tr>
<tr>
<td>1994</td>
<td>1</td>
<td>0.66</td>
</tr>
<tr>
<td>1995</td>
<td>0.956</td>
<td>0.488</td>
</tr>
<tr>
<td>1996</td>
<td>0.727</td>
<td>1</td>
</tr>
<tr>
<td>1997</td>
<td>0.638</td>
<td>0.45</td>
</tr>
<tr>
<td>1998</td>
<td>0.421</td>
<td>0.592</td>
</tr>
<tr>
<td>1999</td>
<td>0.188</td>
<td>0.507</td>
</tr>
<tr>
<td>2000</td>
<td>0.212</td>
<td>0.298</td>
</tr>
</tbody>
</table>

\(^{137}\) The two banks in our sample Sumerbank was privatised in 1995 and Etibank was privatised in 1998.
The results contradict the notion in the literature that privatisation tends to improve the performance of the privatised firm. The explanation for the rather disjointed performance of the privatised banks in Turkey however, coincides with Parker and Kirkpatrick (2005), the authors suggest that one of the reasons that privatisation had mixed effects in developing countries is the lack of a healthy regulatory and economic environment in the post-privatisation period. The case of banking sector privatisation in Turkey simply reflects this argument. Hence, the privatisation decision of these two banks coincided with the period characterised with financial turmoil.

At the same time the government decision to keep supporting the under performing banks and the embarking of deposit insurance scheme seem to reflect a fragile regulatory environment and lack of prudent policies. Beim and Calomiris (2000) argue that in the case where government guarantees banks’ liabilities, prudent policies should take place and government should adopt close monitoring policies on these banks or the financial system will likely suffer massive losses.

Overall in the sample period the state-owned banks seem to outperform other ownership rivals. The private banks tend to mimic the state-owned banks pattern however towards the end of the sample period the efficiency trend diverges and the gap widens between the two ownership groups. In contrast the foreign banks appear to recover from the crisis towards the end of the sample period and outperform the private banks. All the banks turned to SDIF seem to lag behind all other ownership forms and occupy the lower stratum in the efficiency frontier.
Similar to previous studies, the results in the overall sample period assert that the banks turned to SDIF are the least efficient ones. However, unlike El-Gamal and Inanoglu (2005)\textsuperscript{138} who find foreign banks more efficient on average, the present study reports that the state-owned banks are the most efficient compared to the other counterparts (i.e. more efficient in managing resources given a certain level of outputs). The two foreign banks in our sample on average are less efficient than the private and state-owned bank. An interesting finding is that these two particular banks (Osmanli Bank and Arab Turk Bank) obtained lower efficiency levels in El-Gamal and Inanoglu (2005). Moreover the two S_P_SDIF banks namely Sumerbank and Etibank are the least efficient in the El-Gamal and Inanoglu study, which is similar to the present study’s findings.

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Pre-crisis</th>
<th>Crisis</th>
<th>Post-crisis</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>0.96</td>
<td>0.87</td>
<td>0.93</td>
<td>0.93</td>
</tr>
<tr>
<td>Private</td>
<td>0.78</td>
<td>0.83</td>
<td>0.72</td>
<td>0.76</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.84</td>
<td>0.72</td>
<td>0.68</td>
<td>0.73</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>0.70</td>
<td>0.83</td>
<td>0.63</td>
<td>0.69</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>0.95</td>
<td>0.74</td>
<td>0.45</td>
<td>0.62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Efficiency by bank size</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.80</td>
</tr>
</tbody>
</table>

The financial crisis in 1994 affected all forms of banks in terms of efficiency regress. However, the extent of the impact varied among different ownership forms. The small state-owned banks (i.e. S_P_SDIF) seem to be the most affected followed by foreign and state-owned banks respectively. The private banks in contrast experienced adverse effect during the initial years of crisis however the

\textsuperscript{138} El-Gamal and Inanoglu (2005) sample included more 43 banks of which 10 foreign conventional banks. Seven of these banks were in the top ten efficient banks [see El-Gamal and Inanoglu (2005:647)].
efficiency level decline during the post-crisis period. My findings correspond to the notion in the literature “too-big-to-fail”. The large banks in general experience higher levels of efficiency compared to medium and small banks. Moreover, large banks are the least to be affected from the financial crisis in 1994 and the quickest to recover the post-initial shock of the crisis. In contrast the small banks performance started to deteriorate during the post-crisis period unlike the medium size banks, which experienced declining efficiency during and post the initial crisis years.

With regard to banks’ size effect in general; the large banks outperformed the medium and small size banks in terms of efficiency levels on average during the period. The findings are similar to Demir et al, (2005) and Isik and Hassan (2005) results which assert that compare to other size forms the large size banks has performed better in a more liberal environment in Turkey.

Similar to Denizer et al. (2007) findings this study finds that the Turkish banks suffered from scale problem particularly in post-liberalisation period. It seems that the financial turmoil and the instability played major role in the superiority of the state-owned banks in terms of efficiency. From the deposits side, households during such periods are inclined to trust the state-owned banks more than other ownership forms. However, from the loans side another explanation is that the state-owned banks often issue loans on the political basis (i.e. credit directing) rather than on commercial basis (Denizer et al. 2007). The present study’s findings however, contradict with Yildirim and Philippatos, (2002) and Chen et al (2005) findings in the case of Turkish and Chinese banks respectively. Hence, the
former two studies find no evidence of stable performance of the state-owned banks. Furthermore, it is argued that privatisation often leads to efficiency gains. In contrast, the results postulate that the two privatised banks appear to be the least efficient banks in the sample period. Clark et al. (2005) clarified that poorly regulated banking sector diminishes the privatisation gains. The Turkish banks privatisation experience mirrors this argument. The privatised banks were the worst practice post-privatisation. Consequently, the government was forced to convert them to SDIFs eventually.

6.3.2. Productivity of the Turkish banks

This section analyses productivity performance of the Turkish commercial banks and investigates the impact of the crisis on productivity growth. The Malmquist Total Factor Productivity Index (MTFPI) is calculated for each bank following FGNZ (1994). The MTFPI is decomposed to further investigate the main source(s) of productivity progress/regress. These components MTFPI are efficiency progress relative to the best practice frontier (Technical Efficiency Change, ECI) and the shifts in frontier (Technological Change, TCI).

Further decomposition of the technical efficiency change to pure technical efficiency change (PECI) and scale efficiency change (SECI) is also obtained to detect the effect of scale on productivity growth. However, many opposing views emerged in the literature against this decomposition. Nevertheless, the approach remained adopted by many studies given the fact that the debate of the

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139 Fare, Grosskopf, Norris and Zhang (1994)
140 Technical efficiency change (i.e., relative to a CRS technology)
141 Pure technical efficiency change (i.e., relative to a VRS technology)
142 The criticism to this approach is introduced in chapter (4) and Appendix (4)
appropriateness of the underlying assumption of the approach yet to attain any consensus in the literature.

The non-parametric estimation of the productivity index shows that the performance of the sample banks productivity appeared to mimic the volatile unstable financial environment surrounding the industry during the sample period. Figure 6-3-3 illustrates the Malmquist total factor productivity index (MTFPI) average during the sample period is (0.96) which depicts that the sample banks on average experienced approximately (≈ -4.4%) growth in total factor productivity over a period of ten years.

```
```

High volatility is observed in the pattern of technological change index (TCI). The productivity regress mainly stems from an inward shifts in the frontier (i.e. technological regress). The technology regress is –5.5% TCI of (0.94). On the other hand, the pure efficiency change (PECI) has a slight negative contribution

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143 The horizontal red line represent the level of zero growth below the red line is productivity regress however, above the red line is productivity progress.
to the MTFPI by -0.7% on average during the sample period. The scale efficiency change is 1.8% (SECI = 1.017). Two incidents of huge inward shift in the frontier in the years 1992 and 1994 are observed in the graph above which negatively affect the average of the TCI index during the period. Negative productivity growth is evident in the crisis year caused mainly by the significant drop in TCI. In the last four years in the sample period the banks experience productivity regress particularly starting from year 1997. Perhaps, the pressure of the financial instability could not be disregarded by the banks in general and reflected on performance overall.

The post-liberalisation period witnessed two crises in 1994 and in the year 2000. Table 6-3-4 postulates that post crisis deterioration occurred on the MTFPI components. At the beginning of the sample period (i.e. pre-crisis) the slight productivity growth stemmed from pure technical efficiency change. Negative efficiency change and technological regress both offset the improvement in scale efficiency during the initial years of crisis.

<table>
<thead>
<tr>
<th>Period</th>
<th>ECI</th>
<th>TCI</th>
<th>PECI</th>
<th>SECI</th>
<th>MTFPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-crisis</td>
<td>1.092</td>
<td>0.930</td>
<td>1.079</td>
<td>1.012</td>
<td>1.015</td>
</tr>
<tr>
<td>Crisis</td>
<td>1.106</td>
<td>0.887</td>
<td>0.946</td>
<td>1.169</td>
<td>0.981</td>
</tr>
<tr>
<td>Post-crisis</td>
<td>0.946</td>
<td>0.979</td>
<td>0.980</td>
<td>0.965</td>
<td>0.926</td>
</tr>
<tr>
<td>Total</td>
<td>1.011</td>
<td>0.947</td>
<td>0.993</td>
<td>1.018</td>
<td>0.957</td>
</tr>
</tbody>
</table>

The question is whether the efficiency and productivity levels could provide warning signals to the policy makers in the pre-crisis period. The literature on the Turkish banks during this particular period describes the chaos and inconsistency of the policy makers’ decisions. It is important to emphasise in this study that, the
measures of efficiency and productivity of banks performance could be helpful for policy makers even as an auxiliary tool along with others to detect future unfavourable outcomes. Hence, sensing the risk at earlier stage might help policy makers to take defensive measures either to avoid financial instability or to curtail the magnitude of such adverse economic shocks (i.e. financial crisis).

It is perceptible form the results that performance of the Turkish banks has deteriorated dramatically on the last four years of the sample period. Despite the government efforts to stabilise the financial system the contradicting decision and inconsistency in policies led to further deterioration and consequently a second crisis took place in the year 2000.

6.3.2.1. Ownership, Size, Privatisation and Bank’s Productivity:

Figure: 6-3- 4 Malmquist index and its components by bank group
The investigation of the magnitude of the impact of crisis on the efficiency of different bank forms in terms of ownership and size suggests that the financial crisis had dissimilar impacts on different forms of banks’ ownership. Productivity growth per ownership group during the sample period on average is presented in figure 6-3-4. The graph depicts that except the state-owned banks, most of the ownerships group counterparts experienced productivity regress in the study sample.

The results presented in the graph above reflect the fact that private banks were not engaged in traditional banking activities. Hence, during the sample period the private banks exploited the inflationary environment in the Turkish economy and the questionable credibility of the Turkish government at the time. These banks raised funds abroad and provided the Turkish government with financing facilities. The change in the product mix tactics of these banks is reflected in negative productivity in traditional banking activities. Furthermore, it helped spreading the disintermediation wave in the banking sector.

The productivity performance of the banking groups presented in figure 6-3-4 explicates the status of “moral hazard” environment in which the banks were operating. It seems that the source of state-owned banks’ productivity was their ability at producing loans and deposits rather than being able to reduce inputs. The segmented nature of the Turkish banking industry with dominant state-owned banks played a vital role in the stability of these banks during the sample period. Moreover, in the presence of financial instability in emerging economies the household rather deal with the state-owned banks for safety reasons as an
alternative to foreign currency cash and gold. Thereupon, the growth in MTFPI is attributable mainly to scale efficiency progress and slight improvement in technological change. The PECI has slight insignificant contribution to the state-owned banks productivity.

Private and foreign banks have almost identical productivity regress. The negative technological change is expected hence both ownership groups were focused on different product mix hence, different technology. In both ownership groups the technological regress offsets the slight improvement in scale efficiency and the rather insignificant pure efficiency change. Both private and privatised state-owned banks transformed to SDIF, namely P_SDIF and S_P_SDIF respectively are the least productive banks.

Table: 6-3- 5 MTFPI and components by ownership over sub-periods

<table>
<thead>
<tr>
<th>Ownership</th>
<th>TCI</th>
<th>PECI</th>
<th>SECI</th>
<th>MTFPI</th>
<th>MTFP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>1.015</td>
<td>1.005</td>
<td>1.043</td>
<td>1.064</td>
<td>6.2%</td>
</tr>
<tr>
<td>Private</td>
<td>0.935</td>
<td>1.001</td>
<td>1.012</td>
<td>0.947</td>
<td>-5.4%</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.922</td>
<td>1.000</td>
<td>1.028</td>
<td>0.948</td>
<td>-5.3%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>0.948</td>
<td>1.018</td>
<td>0.976</td>
<td>0.942</td>
<td>-6.0%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>0.919</td>
<td>0.858</td>
<td>1.113</td>
<td>0.877</td>
<td>-13.1%</td>
</tr>
<tr>
<td>Pre-crisis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>1.014</td>
<td>1.056</td>
<td>0.930</td>
<td>0.997</td>
<td>-0.3%</td>
</tr>
<tr>
<td>Private</td>
<td>0.934</td>
<td>1.074</td>
<td>1.010</td>
<td>1.013</td>
<td>1.3%</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.920</td>
<td>0.889</td>
<td>1.174</td>
<td>0.960</td>
<td>-4.1%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>0.852</td>
<td>1.273</td>
<td>0.935</td>
<td>1.013</td>
<td>1.3%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>0.949</td>
<td>0.931</td>
<td>1.281</td>
<td>1.131</td>
<td>12.3%</td>
</tr>
<tr>
<td>Crisis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>0.882</td>
<td>0.913</td>
<td>1.478</td>
<td>1.190</td>
<td>17.4%</td>
</tr>
<tr>
<td>Private</td>
<td>0.851</td>
<td>0.968</td>
<td>1.114</td>
<td>0.918</td>
<td>-8.5%</td>
</tr>
<tr>
<td>Foreign</td>
<td>1.019</td>
<td>0.919</td>
<td>1.184</td>
<td>1.108</td>
<td>10.3%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>0.923</td>
<td>0.949</td>
<td>1.045</td>
<td>0.916</td>
<td>-8.8%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>0.947</td>
<td>0.888</td>
<td>1.333</td>
<td>1.122</td>
<td>11.5%</td>
</tr>
<tr>
<td>Post-crisis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>1.074</td>
<td>1.024</td>
<td>0.950</td>
<td>1.044</td>
<td>4.3%</td>
</tr>
<tr>
<td>Private</td>
<td>0.972</td>
<td>0.986</td>
<td>0.974</td>
<td>0.933</td>
<td>-6.9%</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.886</td>
<td>1.085</td>
<td>0.922</td>
<td>0.886</td>
<td>-12.1%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>1.000</td>
<td>0.958</td>
<td>0.966</td>
<td>0.925</td>
<td>-7.8%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>0.897</td>
<td>0.819</td>
<td>0.978</td>
<td>0.718</td>
<td>-33.1%</td>
</tr>
</tbody>
</table>
However, the S_P_SDIF are the worst performers in productivity. In these banks the productivity regress is attributable to a severe regress in technology and efficiency, which in turn offsets the significant improvement in the scale efficiency of such banks.

Since the Turkish banking system was subject to unfavourable economic shocks in different time intervals during the sample period it is likely to observe different response form each groups pre- during and post-economic shocks (i.e. crisis). The average performance of the ownership groups during sub-period in terms of total factor productivity growth and its prominent drivers (PECI, TECI and SECI) is presented in table 6-3-5. The strata classification in the table reveals interesting behaviour for each bank group. Therefore it provides rich material for the arguments in the present study.

The results in table 6-3-5 postulate that foreign banks experience the most productivity regress -4.1% attributable to significant drop in catching up (PECI) which consequently deter the significant growth in scale efficiency (SECI=1.17). In contrast, the state-owned banks seem to experience slight productivity regress attributable to the drop in SCEI that offset the moderate pure efficiency growth. Surprisingly compared to other groups the S_P_SDIF enjoy the highest productivity growth 12.3% the main contributor to such growth is the SECI 1.28. During pre-crisis period private banks seem to be still resided in the competition mode stimulated by liberalisation in the preceding decade. The private banks and P_SDIF (during that time they were classified as private too) focus on catching
up (i.e. improving efficiency) and augment their scale to face the fierce competition from the state-owned large banks.

It is evident from the results that the crisis might have had a reshuffling effect among the ownership forms not only from the performance side but from the production objectives as well. The banks’ perception of the crisis coincided with the “too-big-to-fail” notion in the literature hence, all forms of ownership focused in augmenting their size. Hence an improvement of approximately 20% on average is depicted in SECI during the sample period. The state-owned banks attained the highest level of efficiency change and consequently the highest productivity growth during initial crisis years. The pure efficiency and technological regress depicted in most of the ownership forms reflect the chaos and managerial panic within the internal banks’ environment in addition to the unstable economic environment and the government multiplicity of goals.

To further clarify the aforementioned argument, it seemed that all forms of ownership banks were efficient in augmenting the output side (i.e. scale efficiency progress). Thus, the state-owned banks were the most productive considering the advantages mentioned above. The foreign banks achieved the second rank of high productivity. Hence they not only improved the output side but also improved their efficiency in managing their resources (i.e. input side). The foreign banks would not appear productive if the improvement in

144 The scale efficiency catch-up (SECI) and the pure technical efficiency catch-up (PECI) are orientation dependent. The scale size is measured in inputs when adopting an output orientation whereas when adopting the input orientation the (in the case of present study) the scale size is measured on the outputs (Thanassoulis, 2001).
performance were in one component of the productivity index, which is the case in private banks and the SDIF banks.

During the years of financial tremors high uncertainty and fragility of the financial sector were prevailing. All other ownership forms suffered from significant productivity regress, except the state-owned banks, which achieved positive productivity growth.

The productivity progress in the state-owned banks reflects the efficiency in managing resources (efficiency progress) as well as the perceptive market confidence towards the state-owned banks (i.e. scale efficiency progress). On the other hand, other ownership forms could not survive the market pressure emerged from continuous inflationary environment. Furthermore, the negative efficiency regress mirrors the managerial panic and the fragility of the other forms ownership.

<table>
<thead>
<tr>
<th>Table: 6-3- 6 MTFPI by size during sub-periods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>Overall period</strong></td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td><strong>Pre-crisis</strong></td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td><strong>Crisis</strong></td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td><strong>Post-Crisis</strong></td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>S</td>
</tr>
</tbody>
</table>
The previous discussion insinuates that overall large banks seem to perform better during the sample period within each sub-period. Table 6-3-6 summarises the Malmquist productivity index and its components for the size strata during each sub-period. Table 5-3-6 reveals that small size banks have seized most of the crisis detriment compared to large and medium banks in terms of productivity growth. The large banks seem to stand firm in front of the financial instability during the financial crisis years. The market confidence in big banks is reflected to the farthest scale efficiency change of the large banks\(^{145}\) during the initial crisis.

It is also observed that medium and small size banks productivity regress during the initial crisis period stems from the efficiency and technological regress. The medium and small size banks continued to perform poorly in the post-crisis period and experienced regress in all other drivers of productivity growth.

<table>
<thead>
<tr>
<th>Bank</th>
<th>Year</th>
<th>TCI</th>
<th>PECI</th>
<th>SECI</th>
<th>MTFPI</th>
<th>MTFP%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sumerbank</td>
<td>1992</td>
<td>0.7</td>
<td>1</td>
<td>1</td>
<td>0.7</td>
<td>-35.7%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1992</td>
<td>0.634</td>
<td>1</td>
<td>2.634</td>
<td>1.669</td>
<td>51.2%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>1993</td>
<td>1.084</td>
<td>0.75</td>
<td>0.716</td>
<td>0.582</td>
<td>-54.1%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1993</td>
<td>1.685</td>
<td>1</td>
<td>1.427</td>
<td>2.406</td>
<td>87.8%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>1994</td>
<td>1.063</td>
<td>1.333</td>
<td>0.706</td>
<td>1.002</td>
<td>0.2%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1994</td>
<td>0.649</td>
<td>0.66</td>
<td>2.493</td>
<td>1.067</td>
<td>6.5%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>1995</td>
<td>0.967</td>
<td>0.956</td>
<td>1.813</td>
<td>1.675</td>
<td>51.6%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1995</td>
<td>1.208</td>
<td>0.74</td>
<td>0.99</td>
<td>0.885</td>
<td>-12.2%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>1996</td>
<td>0.953</td>
<td>0.761</td>
<td>0.913</td>
<td>0.662</td>
<td>-41.2%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1996</td>
<td>0.933</td>
<td>2.047</td>
<td>1.015</td>
<td>1.939</td>
<td>66.2%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>1997</td>
<td>0.945</td>
<td>0.877</td>
<td>1.186</td>
<td>0.984</td>
<td>-1.6%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1997</td>
<td>0.766</td>
<td>0.45</td>
<td>0.994</td>
<td>0.343</td>
<td>-107.0%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>1998</td>
<td>0.729</td>
<td>0.659</td>
<td>0.932</td>
<td>0.448</td>
<td>-80.3%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1998</td>
<td>0.74</td>
<td>1.316</td>
<td>0.975</td>
<td>0.95</td>
<td>-5.1%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>1999</td>
<td>1.196</td>
<td>0.448</td>
<td>0.977</td>
<td>0.523</td>
<td>-64.8%</td>
</tr>
<tr>
<td>Etibank</td>
<td>1999</td>
<td>1.107</td>
<td>0.855</td>
<td>0.912</td>
<td>0.863</td>
<td>-14.7%</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>2000</td>
<td>0.881</td>
<td>1.125</td>
<td>0.954</td>
<td>0.946</td>
<td>-5.6%</td>
</tr>
<tr>
<td>Etibank</td>
<td>2000</td>
<td>0.833</td>
<td>0.588</td>
<td>0.951</td>
<td>0.465</td>
<td>-76.6%</td>
</tr>
</tbody>
</table>

\(^{145}\) Worth noting that the large banks strata includes four banks, three of which are the state-owned banks (largest in Turkey) and one large private bank (Imarbank).
The results corroborate with the findings of Demir et al (2003), Isik and Hassan (2005). Hence, these two studies’ findings assert that in the post-liberalisation period large banks attained higher levels of productivity growth compared to small banks.

To further investigate the impact of privatisation on the two privatised banks namely Sumerbank and Etibank, the Malmquist productivity index and its components are presented in table (6-3-7). The government privatises Sumerbank in 1995. It is illustrated from the bank’s result that during the pre-crisis years Sumerbank experience regress in productivity growth. The main driver of productivity regress stems from negative change in scale efficiency. During the post-crisis years significant deterioration in the bank’s efficiency and technological change are the main source of the negative growth however with rather volatile and in some years aggressive productivity pattern.

It is however, difficult to attribute Sumerbank poor performance to either privatisation or the crisis. Hence, the privatisation of the bank occurred initially after the crisis. Both changes in the bank’s internal and external environment might have had a collective negative effect on the performance of the bank. In contrast, Etibank seems to have an outstanding performance in terms of rather significant productivity growth before the crisis in 1994. The main driver for such impressive productivity performance was the farthest growth in scale efficiency (i.e. output side). Nevertheless, in 1995 the bank productivity dropped for the same reason.
Surprisingly, one year before the privatisation in 1998 the bank recorded its highest-level productivity regress during the sample period caused by sharp decline in technological change in the same year. Etibank maintained a poor performance till the end of the sample period derived from a backward shift in the bank’s technology. In the case of the Turkish banks privatisation experience it is difficult to disentangle the effect of crisis from the effect of privatisation on bank performance. Perhaps both economic incidents had negative impact on the privatised banks from different angles. The next chapter aims to overcome this problem using parametric techniques, which incorporate the environmental variables in input-distance function directly.

To summarise, the present section investigated the performance of the Turkish banks during a period characterised with financial instability and encompassed two incidents of financial crisis. The non-parametric methodology DEA and the DEA based Malmquist Productivity Index are estimated in order to measure the efficiency and productivity of the Turkish banks respectively.

The findings of this section implied that state-owned banks were the most efficient particularly because of the scale effect. Hence, the state-owned banks were advantaged from the output (loans and deposits) side compared to the other ownership categories. The crisis, negatively affected the performance of the Turkish banks in the long run however, large size and state-owned banks seems to survive the financial turmoil.
Turkey had a disappointing experience in privatising state-owned banks perhaps policy makers were not successful in the timing of the privatisation. The government privatised Sumerbank initially after the financial crisis in 1994. It is arguable that both privatisation and crisis might have detrimental impact on the privatised banks. Nevertheless, the methodology used in this section did not provide enough evidence on which one had more negative effect. Moreover, it postulated from the results that it is fairly difficult to disentangle the effect of the both crisis and privatisation on the privatised banks.
6.4. The Parametric Empirical Results

The current section aims to provide analytical discussion for the parametric results of efficiency and productivity estimation of the Turkish banks. The parametric methods require pre-assumption of the model. It is important to note that, parametric estimation provides an advantage over the non-parametric methods (linear programming DEA) by allowing for tests of statistical significance of either the model fitness or the model’s parameters. Similar to the non-parametric estimation in this section the production approach is employed. The input distance function is exploited to estimate the stochastic frontier and technical efficiency.

The main advantage of using such techniques that, it does not require information about input prices neither prior assumption regarding the competition (i.e. cost/profit function). The current section present the results of parametric estimation of twelve models of which the main discussion will focus on the main five models. Hence the other models are nested and statistically rejected. The productivity analyses will be presented later in this section using the parameters from the selected models to estimate the Generalised Malmquist Total Factor Productivity Index (GMTFPI) and its decomposition of efficiency change, technological change and scale change following Orea (2002). The current section mirrors the same procedures followed in section (5-4) of the thesis. The main difference is the use of production approach rather than intermediation approach for the reasons summarised at the beginning of this chapter. The same inputs and outputs structure are used similar to the non-parametric estimation.
The estimation results of five different model specifications are presented in table (6-4-1). The five models represent four cases; Case 1 assumes that environmental and bank-specific factors do not affect efficiency or the production technology. Case 2 assumes that environmental and bank-specific factors affect banks’ efficiency. Case 3 assumes that environmental and bank-specific factors in addition to time trend affect banks’ efficiency. Case 4 suggests that the environmental and bank-specific factors have direct impact on the banks’ production technology.

**Case 1- Efficiency estimates without environmental effect**

In Case 1, three models are estimated in all of which the parameters of the input distance function do not incorporate environmental and bank-specific factors. Model one (M1) [table 6-4-1)] is estimated as the base model assuming a time-variant efficiency component \( \mu \), which follows a truncated normal distribution following Battese and Coelli (1992). However, to test if the model is truly specified another three sub-models (nested in models) are estimated and tested using the likelihood ratio test.

The first model (M0) assumes a time invariant efficiency model hence \( \eta \) is restricted to zero \( (\eta = 0) \) [i.e. Battese and Coelli (1998)]. However, the second model (M1a) suggests a half normal distribution with \( \mu \) is restricted to zero \( (\mu = 0) \) [i.e. Pitt and Lee (1981)]. The null hypothesis that model one (M1) is consistent however not truly specified is tested against both M0 and M1a using
the log likelihood test. The log likelihood ratio tests (LR) for both M0 and M1
[Table (6-4-2)] are rejected at 99% significance level.

<table>
<thead>
<tr>
<th>Variables</th>
<th>M1</th>
<th>M2</th>
<th>M3a</th>
<th>M4a</th>
<th>M5c</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>coeff</td>
<td>Sign level</td>
<td>coeff</td>
<td>Sign level</td>
<td>coeff</td>
</tr>
<tr>
<td>lnX1</td>
<td>0.899</td>
<td>***</td>
<td>0.504</td>
<td>***</td>
<td>-1.384</td>
</tr>
<tr>
<td>lnX2</td>
<td>-0.449</td>
<td>***</td>
<td>-0.333</td>
<td>***</td>
<td>-0.269</td>
</tr>
<tr>
<td>lnX3</td>
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<td>***</td>
<td>-0.365</td>
<td>***</td>
<td>-0.369</td>
</tr>
<tr>
<td>lnX11</td>
<td>-0.579</td>
<td>***</td>
<td>-0.839</td>
<td>***</td>
<td>-0.728</td>
</tr>
<tr>
<td>lnX12</td>
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<td>***</td>
<td>0.929</td>
<td>***</td>
<td>0.922</td>
</tr>
<tr>
<td>t</td>
<td>0.370</td>
<td>*</td>
<td>0.496</td>
<td>***</td>
<td>0.492</td>
</tr>
<tr>
<td>lnY11</td>
<td>-0.327</td>
<td>***</td>
<td>-0.260</td>
<td>***</td>
<td>-0.230</td>
</tr>
<tr>
<td>lnY22</td>
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<td>***</td>
<td>-0.410</td>
<td>***</td>
<td>-0.391</td>
</tr>
<tr>
<td>lnY33</td>
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<td>ins</td>
<td>0.021</td>
<td>ins</td>
<td>0.011</td>
</tr>
<tr>
<td>lnX11</td>
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<td>***</td>
<td>-0.156</td>
<td>***</td>
<td>-0.168</td>
</tr>
<tr>
<td>tt</td>
<td>0.239</td>
<td>ins</td>
<td>0.493</td>
<td>**</td>
<td>0.660</td>
</tr>
<tr>
<td>lnY1y2</td>
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<td>***</td>
<td>0.339</td>
<td>***</td>
<td>0.321</td>
</tr>
<tr>
<td>lnY3y3</td>
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<td>ins</td>
<td>0.041</td>
<td>ins</td>
<td>0.002</td>
</tr>
<tr>
<td>lnY1X1</td>
<td>-0.208</td>
<td>***</td>
<td>-0.133</td>
<td>***</td>
<td>-0.194</td>
</tr>
<tr>
<td>lnY2y3</td>
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<td>ins</td>
<td>-0.078</td>
<td>ins</td>
<td>-0.038</td>
</tr>
<tr>
<td>lnY2X1</td>
<td>0.144</td>
<td>***</td>
<td>0.105</td>
<td>**</td>
<td>0.150</td>
</tr>
<tr>
<td>lnY3X1</td>
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<td>**</td>
<td>-0.145</td>
<td>ins</td>
<td>-0.125</td>
</tr>
<tr>
<td>lnY1t</td>
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<td>*</td>
<td>0.153</td>
<td>**</td>
<td>0.119</td>
</tr>
<tr>
<td>lnY2t</td>
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<td>ins</td>
<td>-0.151</td>
<td>**</td>
<td>-0.161</td>
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<td>0.990</td>
</tr>
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<td>lnY1t</td>
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<td>***</td>
<td>-0.076</td>
<td>ins</td>
<td>-0.015</td>
</tr>
<tr>
<td>opek</td>
<td>-0.265</td>
<td>ins</td>
<td>-0.555</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>gdp</td>
<td>-0.241</td>
<td>*</td>
<td>-0.408</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>l_dum</td>
<td>-0.458</td>
<td>*</td>
<td>-0.241</td>
<td>ins</td>
<td></td>
</tr>
<tr>
<td>m_dum</td>
<td>0.014</td>
<td>ins</td>
<td>0.086</td>
<td>ins</td>
<td></td>
</tr>
<tr>
<td>statdum</td>
<td>0.028</td>
<td>ins</td>
<td>0.117</td>
<td>ins</td>
<td></td>
</tr>
<tr>
<td>priv_dum</td>
<td>-0.089</td>
<td>ins</td>
<td>-0.349</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>sif_dum</td>
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<td>ins</td>
<td>-0.044</td>
<td>ins</td>
<td></td>
</tr>
<tr>
<td>crisis_dum</td>
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<td>***</td>
<td>1.025</td>
<td>***</td>
<td>0.740</td>
</tr>
<tr>
<td>Cons</td>
<td>-0.146</td>
<td>*</td>
<td>-0.278</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>w</td>
<td>0.028</td>
<td>ins</td>
<td>0.033</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>w</td>
<td>0.111</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gdp</td>
<td>0.485</td>
<td>**</td>
<td>0.487</td>
<td>ins</td>
<td>-0.271</td>
</tr>
<tr>
<td>l_dum</td>
<td>0.252</td>
<td>*</td>
<td>0.279</td>
<td>***</td>
<td>-0.267</td>
</tr>
<tr>
<td>m_dum</td>
<td>0.034</td>
<td>ins</td>
<td>0.112</td>
<td>**</td>
<td>-0.454</td>
</tr>
<tr>
<td>statdum</td>
<td>-0.150</td>
<td>ins</td>
<td>-0.087</td>
<td>ins</td>
<td>-0.007</td>
</tr>
<tr>
<td>priv_dum</td>
<td>0.071</td>
<td>ins</td>
<td>0.044</td>
<td>ins</td>
<td>0.241</td>
</tr>
<tr>
<td>sif_dum</td>
<td>0.461</td>
<td>*</td>
<td>0.139</td>
<td>ins</td>
<td>-0.004</td>
</tr>
<tr>
<td>crisis_dum</td>
<td>0.416</td>
<td>**</td>
<td>-0.058</td>
<td>ins</td>
<td>-0.421</td>
</tr>
<tr>
<td>sigma-squared</td>
<td>0.581</td>
<td>***</td>
<td>0.160</td>
<td>***</td>
<td>0.155</td>
</tr>
<tr>
<td>gamma</td>
<td>1.408</td>
<td>***</td>
<td>1.300</td>
<td>***</td>
<td>0.722</td>
</tr>
<tr>
<td>eta</td>
<td>-0.141</td>
<td>***</td>
<td>-0.155</td>
<td>***</td>
<td>-0.304</td>
</tr>
<tr>
<td>Log likelihood function = -89.47</td>
<td>-127.70</td>
<td>-127.94</td>
<td>-76.66</td>
<td>-117.59</td>
<td></td>
</tr>
</tbody>
</table>
The likelihood test suggests that model one, M1\textsuperscript{146} is consistent and truly specified (i.e. is preferred) to estimate the efficiency of the Turkish banks. Furthermore, the likelihood test suggests that $\mu_\mu$ is time-variant and a truncated normal distribution is more suitable for the inefficiency estimates. In table 6-4-2 the null hypothesis that the parameters can be estimated using ordinary least squares\textsuperscript{147} (OLS) $\gamma = \mu = \eta = 0$ are also rejected at 99\% significance Hence $\gamma \neq 0$ indicates that $\sigma_u^2 \neq 0$ and consequently asserts the existence of inefficiency.

It is worth noting that model one (M1) which does not incorporate environmental factors, is rejected in favour of case 2, 3 and 4 models [table (6-4-3)] on the basis of likelihood ratio test. These results seem to imply that environmental and bank-specific factors cannot be neglected in estimating banks’ productivity and efficiency. Furthermore the likelihood test suggests that $\mu_\mu$ is time-variant and a truncated normal distribution is more suitable for the inefficiency estimates. In table (6-4-2) the null hypothesis that the parameters can be estimated using ordinary least squares (OLS) $\gamma = \mu = \eta = 0$ are also rejected at 99\% significance hence $\gamma \neq 0$

\textsuperscript{146} Model one (M1) parameters are presented in table (6-4-1)

\textsuperscript{147} The FRONTIER software uses a three steps estimation method to obtain the final maximum-likelihood estimates. First, estimates of $\alpha$-parameter are obtained by OLS. A two grid search for $\gamma$ is conducted in the second step with $\alpha$-estimates set to OLS values and other parameters set to zero. The third step involves an iterative procedure, using Davidson-Fetcher-Powel Quasi-Newton method to obtain final maximum-likelihood estimates with the values selected in the grid search as starting values.
Case 2- Inefficiency Effect Models

In case 2, the input distance function is estimated assuming that environmental and bank-specific factors affect inefficiency (Battese and Coelli, 1995). Two models are estimated in case 2 (M2 and M2a). In both models the assumptions that time trends explain inefficiency is neglected. The likelihood ratio test rejects\(^{148}\) the null hypothesis that \(\gamma = 0\) for both models therefore implying that inefficiency is present in both. Furthermore, the null hypothesis that \(\delta' = 0\) (where \(\delta'\) includes \(\delta_1 = \delta_2 = \ldots \delta_j\)) is rejected at 95% level consequently the result suggests that the environmental and bank-specific factors explains inefficiency is also present [see table (6-4-2)]

However, when testing if model two (M2) is truly specified compared to M2a specification the likelihood ratio test rejects the null hypothesis that \(\delta'_{\text{openk}} = \delta'_{\text{gdpg}} = 0\). Therefore, model 2 (M2)\(^ {149}\) is preferred in favour of M2a [table (6-4-2)] consequently implying that macroeconomic variables gdpg and openk explain the inefficiency of the Turkish banks. It is significant to note that Case 1 models are not nested in Case 2 models (Coelli, Perelman and Romano, 1999).

Case 3-Inefficiency Effect Models with time trend

Two models (M3 and M3a) are estimated employing the input distance function. The main assumption of case three models is that time trends explain inefficiency.

\(^{148}\) The critical value for any test involving \(\gamma = 0\) is obtained from Table1 of Kodde and Palm (1986, p1246). Hence, the asymptotic distribution of \(\lambda\) is approximately a mixed chi-square distribution (Battese & Coelli, 1995).

\(^{149}\) The parameters of M2 are presented in table (6-4-1)
Following Kumbhakar and Wang (2007), time trend (t and \( t^2 \)) are added to the factors affecting inefficiency. The results also assert the existence of inefficiency effects in both models. The likelihood ratio tests reject the null hypothesis that \( \gamma = 0 \). However, the likelihood ratio test fails to reject the null hypothesis that \((\delta_{openk} = \delta_{gdpg} = 0)\). Consequently M3 is rejected in favour of M3a [table (6-4-2)], which confirms that these particular macroeconomic variables do not explain the variation of mean inefficiency of the Turkish banks.

On the other hand, M2 and M2a are nested in M3 and M3a respectively. The likelihood ratio test fails to reject the null hypothesis that \( \psi_1 = \psi_2 = 0 \) at confidence level 95% [table (6-4-2)] thus, time trends parameters do not explain the variation in average inefficiency. Consequently, both models M2 and M2a are favoured against M3 and M3a respectively. Coelli, Perelman and Romano (1999)

150 The parameters of Model 3a are presented in table (6-4-1)
described the technical efficiency obtained from case 2 and case 3 models as “gross measure of efficiency”. In other words the technical efficiency is gross of environmental and bank-specific variables.

Case 4: Environmental Variables Influence the Shape of the Production Technology

In contrast to case 3, case 4 assumes that both environmental and bank-specific variables influence the shape the production technology. Hence, two models are estimated as M4 and M4a in which environmental and bank-specific variables are incorporated directly into the input distance function [e.g. Good et al. (1993), Coelli Perelman and Romano (1999), and Hattori (2002)]151. In both models the null hypothesis that \( \gamma = \zeta' = 0 \) (where \( \zeta' \) includes \( \zeta_1 = \zeta_2 = \zeta_3 = \ldots \zeta_i \)) and is rejected at 99% confidence level. This result indicates that existence of inefficiency is true and suggests that environmental and bank-specific variables influence the shape of technology in the Turkish banks.

In case four M4 [table (6-4-2)] is rejected in favour of M4a, the LR test fail to reject the null hypothesis that \( \zeta_{openk} = \zeta_{gdp} = 0 \) and is rejected at 90% confidence level implying that these particular macroeconomic variables does not influence the shape of production technology. Following Coelli, Perelman and Romano (1999) the technical efficiency obtained from M4 described as “net measure of technical efficiency” (i.e. net of environmental and bank-specific variables).

151 Note that Model 4 assumes separability of the environment and bank specific variables (i.e. these variables do not interact with the input distance function variables). A more general model is non separability where the environmental variables interact multiplicatively with the input distance parameters. Nevertheless, it is out of the scope of this thesis.
6.4.1. Testing model specification in each Case

This chapter provides a proper estimation for the efficiency and productivity of Turkish banks during a period, which was characterised by financial instability. Different model specifications for the input distance function were estimated in order to select the most appropriately specified model to measure Turkish banking efficiency. This approach facilitates testing the robustness of each model using the likelihood ratio test LR. This approach is adopted by many studies for instance, Coelli, Perelman and Romano (1999), Hattori (2002) and Sensarma (2006).

Table: 6-4- 3 Models’ specification test

<table>
<thead>
<tr>
<th>Nested Models</th>
<th>Null Hypothesis</th>
<th>df</th>
<th>LR(^{152})</th>
<th>Decision</th>
<th>(\chi^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(H_0: M2a) is truly specified</td>
<td>(H_0: \delta_{\text{spec}} = \delta_{\text{gdpg}} = 0)</td>
<td>2</td>
<td>14.60**</td>
<td>*** Accept Model 2</td>
<td>4.605 5.991 9.21</td>
</tr>
<tr>
<td>(H_0: M3a) is truly specified</td>
<td>(H_0: \Psi_1 = \Psi_2 = 0)</td>
<td>2</td>
<td>-0.22</td>
<td>Accept Model 3a</td>
<td>4.605 5.991 9.21</td>
</tr>
<tr>
<td>(H_0: M2a) is truly specified</td>
<td>(H_0: \zeta_{\text{openk}} = \zeta_{\text{gdpg}} = 0)</td>
<td>12</td>
<td>26.19**</td>
<td>** Accept Model 4</td>
<td>18.549 21.026 26.217</td>
</tr>
<tr>
<td>(H_0: M4a) is truly specified</td>
<td>(H_0: \zeta_{\text{openk}} = \zeta_{\text{gdpg}} = 0)</td>
<td>2</td>
<td>0.57</td>
<td>Accept Model 4a</td>
<td>4.605 5.991 9.21</td>
</tr>
<tr>
<td>(H_0: M3a) is truly specified</td>
<td>(H_0: \zeta_{\text{openk}} = \zeta_{\text{gdpg}} = 0)</td>
<td>7</td>
<td>20.70**</td>
<td>*** Reject M3a</td>
<td>12.017 14.067 18.475</td>
</tr>
<tr>
<td>(H_0: M4a) is truly specified</td>
<td>(H_0: \delta = 0)</td>
<td>10</td>
<td>-81.86***</td>
<td>Accept Model 4a</td>
<td>15.987 18.307 23.209</td>
</tr>
</tbody>
</table>

The estimated parameters of the input distance function of four different model specifications (four cases) are presented in the previous section [table (6-4-1)].

Table (6-4-2) presents the hypothesis test for each model, and table (6-4-3) presents the results of the hypothesis test for the validity of each model specification.

\[ LR = -2[\ln L_R - \ln L_U] \] Where R: restricted and U: unrestricted

\(^{152}\)
It is worth noting that Case one models are not nested in case two models hence, they cannot be tested against each other. Similarly Case four models are not nested in Case three models. Nevertheless, Case one models could be treated as special case of Case 4 models. Therefore, the construction of the generalised model, which combines the four cases model specifications, is deemed essential in order to conduct such test. Following Coelli, Perelman and Romano (1999) and others, the generalised model (M5) is constructed. Model five incorporates environmental and bank-specific variables directly into the input distance function (i.e. assuming it affect the shape of technology). In addition, the model also assimilates the same environmental and bank-specific variables to affect the inefficiency.

According to the likelihood test [see table (6-4-3)] M3a is rejected in favour of M2a at 90% confidence level (i.e. $\psi_1, \psi_2 \neq 0$). Furthermore, M2a is rejected in favour of M2 at 99% confidence (i.e. $\delta_{openk} = \delta_{gdpg} = 0$). These results imply that the model specifications according to Case 2 are preferred in measuring the Turkish banks efficiency. Moreover, the macroeconomic variables openk and gdpg used are influencing the variability in average inefficiency in the Turkish case.

Hence Case one models are nested in Case four models and the likelihood ratio test rejects the M1 in favour for M4. Furthermore, M4a is favoured over M4 at 99% confidence level. These results suggest that in the Turkish case both environmental and bank-specific variables affect the shape of production
technology (i.e., $\zeta' \neq 0$). Consequently, ignoring such effect will result in biased efficiency measures. Unlike the inefficiency models’ specifications, the macroeconomic variables openk and gdpq do not influence the shape of the production technology (i.e. $\zeta_{openk}, \zeta_{gdpq} = 0$).

The likelihood test to choose among the four cases which would be the preferred in measuring the Turkish banks efficiency reveals that Case four model specification is the most preferred at 99% confidence level. Hence, M1, M2a and M3a, are all rejected in favour of M5 (The generalised model) at 99% confidence level. The likelihood ratio test rejects M4. Consequently, M4a is the preferred model to measure the efficiency of the Turkish banks. Hence, the environmental and bank-specific variables are most likely affecting the shape of technology rather that the variability in average inefficiency. Based on these findings, M4a parameters will be used to estimate the Malmquist productivity index following Orea (2002) in later section in this chapter. In the next section a comparison between the efficiency estimates from the four cases will be presented and the rest of the next section focuses on discussing the efficiency of the Turkish banks according to the M4 estimation.

**6.4.2. Comparison between the Estimated Efficiency**

According to Coelli, Perelman and Romano (1999) the estimated technical efficiencies are expected to vary for each model specification. Hence M2 and M3a are expected to provide gross efficiency, M4 and M1 produces net technical efficiency. Table (6-4-4) presents summary statistics of the technical efficiency
for each model. Consequently $\gamma$ is different for each model due to the computational procedures. Hence, it is interesting to present $\gamma$ values for each model for comparison reason. The $\gamma$ in M1 is higher compared to all other models and it drops to the least in M2. M3a produces $\gamma$ value for approximately equal to one, which implies that the inefficiency is very high, and almost explains all the variability in production.

The correlation matrix illustrated in table 6-4-4 shows that the estimated technical efficiency for inefficiency models (M1, M4a) are highly correlated ($R^2 = 0.95$).

\[ \gamma = \frac{\sigma_i^e}{\sigma_i^u + \sigma_i^e} \]

\[ 153 \] the computational procedures for $\gamma$ differ for each model specification (i.e. M1 and M 22)

\[ 154 \] $\gamma$ is significant at 99% level for all models.
Furthermore there is a slight difference in the average estimated technical efficiency for both models. On the other hand, despite the high discrepancies in average efficiency depicted between the inefficiency effect models M2 and M3a, there is high correlation between the two models estimated efficiency scores. Overall there is significant positive correlation between the estimated technical efficiency (TE) in the four models specification [see table (6-4-5)]. The observed discrepancy between various models’ estimated technical efficiency is similar to Coelli, Perelman and Romano (1999) findings. Hence, they argued that it is expected and permissible due to the different computational procedures of the one-sided error in each model.

Figure: 6-4-1 Kernel density distribution for the estimated technical efficiency
Figure 6-4-1 illustrates the Kernel density\textsuperscript{155} distribution of the technical efficiency estimated using different model specification (M1, M2, M3a and M4a). The graphs in figure 6-4-1 depict the changes of technical efficiency distribution according to each model specification.

It is worth noting that it is difficult to compare directly the distribution among the models’ specification because of the differences in the underlying assumptions for each model. However, the graphs above give insight on the choice of the models specification. It seems that Model two (M2) is bimodal\textsuperscript{156} (i.e. encompasses two modes) with two peaks. On the other hand M3a is negatively skewed implying high levels of inefficiency. Model one (M1) and model four (A) (M4a) in contrast are tend to be unimodal, with modes 0.50, 0.52 respectively. Furthermore, in these particular models, the technical efficiency seems to be more likely normally distributed (i.e. mean=median=mode) compared to other alternative models. On the other hand in both inefficiency-effects models (M2) and (M3a) the technical efficiency (TE) distribution seems to be skewed to the right in the former and to the left in the last.

\textsuperscript{155} A kernel density plot can be regarded as a smoothed version of a histogram (Silverman, 1986) and directly comparable with a normal distribution. The kernel density illustrated in figure (6-4-1) is obtained using the standard command for kernel density in STATA 9.1, assuming optimal width and Epanechnikov kernel function.

\textsuperscript{156} In case the data is distributed bimodally, the mean cannot be interpreted as the most typical value.
6.4.3. The Parametric Efficiency of the Turkish Banks

Turning to the preferred model Case four (M4a) this model is verified by the likelihood ratio test among other alternative models to be the consistent and the truly specified model to estimate the technical efficiency of the Turkish banks.

Table: 6-4-6 Model four (a) “The Selected Model”

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sym</th>
<th>coeff</th>
<th>t-ratio</th>
<th>Sign level</th>
<th>Variables</th>
<th>Sym</th>
<th>coeff</th>
<th>t-ratio</th>
<th>Sign level</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnxn</td>
<td>α</td>
<td>0.997</td>
<td>4.339</td>
<td>***</td>
<td>crisis_dum</td>
<td>ζ₈</td>
<td>-0.089</td>
<td>-1.203</td>
<td>ins</td>
</tr>
<tr>
<td>lny1</td>
<td>β₁</td>
<td>-0.355</td>
<td>-6.123</td>
<td>***</td>
<td>stablis_dum</td>
<td>ζ₉</td>
<td>0.085</td>
<td>1.484</td>
<td>ins</td>
</tr>
<tr>
<td>lny2</td>
<td>β₂</td>
<td>-0.313</td>
<td>-6.122</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny3</td>
<td>β₃</td>
<td>-0.662</td>
<td>-4.436</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnX1</td>
<td>β₄</td>
<td>0.768</td>
<td>20.046</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>β₅</td>
<td>0.251</td>
<td>1.570</td>
<td>ins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny11</td>
<td>β₆</td>
<td>-0.307</td>
<td>-5.492</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny22</td>
<td>β₇</td>
<td>-0.388</td>
<td>-5.453</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny33</td>
<td>β₈</td>
<td>-0.016</td>
<td>-0.436</td>
<td>ins</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>lnX11</td>
<td>β₉</td>
<td>-0.126</td>
<td>-3.105</td>
<td>***</td>
<td></td>
<td></td>
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<tr>
<td>tt</td>
<td>β₁₀</td>
<td>0.182</td>
<td>1.083</td>
<td>ins</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>lny1y2</td>
<td>β₁₁</td>
<td>0.328</td>
<td>5.291</td>
<td>***</td>
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</tr>
<tr>
<td>lny1y3</td>
<td>β₁₂</td>
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<td>ins</td>
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<td>lny1X1</td>
<td>β₁₃</td>
<td>-0.228</td>
<td>-5.085</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>lny2y3</td>
<td>β₁₄</td>
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<td>ins</td>
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<tr>
<td>lny2X1</td>
<td>β₁₅</td>
<td>0.155</td>
<td>3.399</td>
<td>***</td>
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<tr>
<td>lny3X1</td>
<td>β₁₆</td>
<td>-0.200</td>
<td>-2.263</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>lny1t</td>
<td>β₁₇</td>
<td>0.068</td>
<td>1.187</td>
<td>ins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lny2t</td>
<td>β₁₈</td>
<td>-0.069</td>
<td>-1.144</td>
<td>ins</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>lny3t</td>
<td>β₁₉</td>
<td>0.951</td>
<td>5.595</td>
<td>***</td>
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<td></td>
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</tr>
<tr>
<td>lnX1t</td>
<td>β₂₀</td>
<td>-0.136</td>
<td>-3.347</td>
<td>***</td>
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</table>

Hypothesis test

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₀: η=0</td>
<td>26.25</td>
<td>*** Reject Ho</td>
</tr>
<tr>
<td>H₀: μ=0</td>
<td>4.54</td>
<td>** Reject Ho</td>
</tr>
<tr>
<td>H₀: γ=μ=η=0</td>
<td>88.49</td>
<td>*** Reject Ho</td>
</tr>
<tr>
<td>H₀: γμ=η=0</td>
<td>318.40</td>
<td>*** Reject Ho</td>
</tr>
<tr>
<td>H₀: ζ₁=0</td>
<td>25.62</td>
<td>** Reject Ho</td>
</tr>
<tr>
<td>H₀: ζ₂=0</td>
<td>25.62</td>
<td>** Reject Ho</td>
</tr>
<tr>
<td>RTS¹⁵⁸</td>
<td>-1.3299</td>
<td>Decreasing return to scale</td>
</tr>
</tbody>
</table>

¹⁵⁷ The critical value for any test involving γ = 0 is obtained from Table1 of Kodde and Palm (1986, p1246)

¹⁵⁸ Input distance function returns to scale (RTS) = \(-\left(1/\sum_{m=1}^{3} \beta_m\right)\)=0.752 (Fare and Primont, 1995).
In table 6-4-6 the estimated outputs’ coefficients ($\beta_1, \beta_2, and \beta_3$) satisfy the monotonicity assumptions hence, all the outputs coefficients are significant at 99% level and have the expected negative sign.

The estimated coefficients for the normalised inputs variables ($\beta_4, and \beta_5$) also have the expected positive sign and all are significant at 99% level. Both time trend coefficients for $t$ and $t^2$ are positive and however both are insignificant at levels 90%, which imply technological progress overtime during the sample period at increasing rate but statistically insignificant. In contrast, the outputs second order coefficients associated with time trend ($t$) are all insignificant except the other income ($y3$)$^{159}$ is positive and significant at 99% which is expected considering the volatile growth in deposits and loans.

The inputs second order coefficient associated with time trend are significant. The normalised inputs $X1$ is negative and significant at 99% level. The coefficient of the crisis dummy variable (-0.089) is negative as expected which coincides with the study assumption that the financial crisis in 1994 has negatively influenced the shape of production technology of the Turkish banks. The stabilisation dummy variable has the positive sign as expected implying that the stabilisation efforts by the Turkish government have improved efficiency. However the both variables are statistically insignificant at 90% level, implying that the effect of crisis and stabilisation is not observed or detected in the data.

The size effect on the shape of production technology is not clearly identified in the data hence the dummy variables of large (L) and medium (M) size Turkish

$^{159}$ Other income.
banks are both negative however, the medium size dummy is only significant at 90\% level. The results suggest that the small size banks (base case) seem to be more successful in technological progress in comparison to large and medium size banks. On the other hand only the state-owned dummy is statistically insignificant out of all the ownership variables. The state-owned ownership of banks seems to have negative impact on the shape of the production technology of that particular ownership category. It seems that from the coefficients of the ownership dummy variables namely state-owned, private and SDIF that the foreign owned banks (base case) experienced the highest technological progress.

Despite the t test results on the coefficients of some environmental and bank-specific variables are insignificant the LR test of whether the environmental and bank-specific variables are affecting the shape of the production technology rejects the null hypothesis that ($\zeta' = 0$) at 99\% level. Moreover, $\eta$ is negative and statistically significant which implies that the Turkish banks efficiency deteriorates over time. The hypothesis tests of $\mu = 0$ reject the null hypothesis that the Turkish banks inefficiency is time-invariant at 99\%. The LR test of $\gamma = 0$ is also rejected at 99\% level, which asserts the existence of technical inefficiency in the sample period.

The hypothesis test for returns to scale\textsuperscript{160} rejects the null hypothesis ($\beta_1 + \beta_2 + \beta_3 = -1$) that the Turkish banks exhibit constant returns to scale at

\textsuperscript{160}FRONTIER 4.1 does not provide return to scale test however, it provides the variance covariance matrix from which to extract the variance covariance is extracted.
99% level\textsuperscript{161}. The scale elasticity of the input distance function is measured by the negative inverse of the sum of the output elasticities [see Fare and Primont (1995, p.38-40)]. Consequently it seems that the Turkish banks experienced decreasing return to scale (0.752) during the sample period.

Figure: 6-4-2 Technical Efficiency (M4a)

Figure 6-4-2 illustrates the trend of technical efficiency of the Turkish banks as well as the kernel density distribution of the technical efficiency during two sub-periods, pre-crisis (1991-1993), and post-crisis (1994-2000). The Kernel density distribution depicts the regress of banks efficiency during post-crisis period compared to the pre-crisis periods. The shift of the mean/mode to the left hand side post-crisis demonstrates the regress in average efficiency and the movement

\[ t = \frac{(\beta_1 + \beta_2 + \beta_3) - \text{(hypothesized value)}}{se}, \quad se = \sqrt{\text{var}_{\beta_1} + \text{var}_{\beta_2} + \text{var}_{\beta_3} + 2(\text{cov}_{\beta_1\beta_2} + \text{cov}_{\beta_1\beta_3} + \text{cov}_{\beta_2\beta_3})} \]
of the mean/mode towards lower efficiency levels with higher density levels compare to pre-crisis period.

The box plot graph also reveals the declining trends in efficiency of the Turkish banks during the sample period over all. Moreover it seems that the gap between the best practice banks and average efficient banks are widening towards the end of the sample period. The box plot graph also implies that the effect of the unfavourable economic environment has different magnitude on influencing the banks performance. Hence, the best practice banks seem to have a moderate downward slope in efficiency. On the other hand the banks below the frontier seem to have a rather steeper downward slop in efficiency towards the end of the sample period. The parametric results coincide with the findings of Fethi et al. (1998), Isik et al. (2002) and Denizer et al. (2007), which find a declining trend in the efficiency of Turkish banks during post-liberalisation particularly towards the end.

6.4.3.1. Ownership, Size and Bank’s Efficiency

The current section investigates the efficiency performance of different ownership and different banks size. The magnitude of economic reforms vis a vis economic shocks could vary among the different forms of banks’ ownership and size [See among others Isik et al. (2002) and Isik and Hassan (2002)]. Similar to the non-parametric results, the parametric estimation of the Turkish banks’ technical efficiency postulates that state-owned banks tend to perform more efficient compared to foreign and private banks.

162 The scholars considered after the year 1990 as post liberalisation period.
Figure 6-4-3 illustrates that privatised state-owned later turned to SDIF (S\_P\_SDIF) are the least efficient ones compared to other ownership forms. The private banks are the second in terms of efficiency after the state banks. The foreign banks are third in terms of efficiency scores. In general the banks turned to SDIF are the least efficient. El-Gamal and Inanoglu (2005) also find that the SDIF banks are the least efficient however, the foreign banks in their study seem to be the most efficient banks. Zaim (1995) finds state-owned banks tend to outperform other ownership categories. During the sample period it seems that state-owned banks sustained its superiority in terms of average efficiency compare to private, foreign and SDIF banks as depicted in figure 6-4-3. Nevertheless, all banks experienced a declining trend in efficiency the Turkish economy overall during the sample period were subject to sever financial shock represented in high inflation and currency devaluation (i.e. financial crisis).

![Figure: 6-4-3 Technical efficiency by ownership category](image-url)
It seems that the poor economic situation and the financial instability have overwhelmed the performance of the banking sector over all. Hence, it seems that these circumstances have outweighed the efficiency gains obtained during the liberalisation period [El-Gamal and Inanoglu, (2005) and Denizer et al., (2007)]. Similarly, Denizer et al., (2007) observed a stable pattern of the state-owned banks efficiency level in their analysis for the Turkish banks efficiency performance. The present section also aims to shed light on the discrepancies in the efficiency performance among different sizes of banks. In general during the sample period the large banks tend to outperform medium and small banks in terms of average efficiency. There is not significant difference between medium and small banks average efficiency. Furthermore, however, it seems that medium and small banks were almost catching up with the large banks pre-crisis period.

However, during the initial years of crisis and the periods followed a slight significant gap emerges between the performance of both medium and small bank and the large banks average efficiency. This efficiency gap tends to widen towards the end of the sample period. The reason for such pattern is that the financially distressed banks belong to the medium and small size strata. However, the large banks are composed of the large state-owned banks in the sample.
According to Demir et al. (2005) and Isik and Hassan (2003) that large size banks also tend to perform better than small and medium. Turning to the Turkish experience in privatising state-owned banks, the Turkish government started the banks’ privatisation program in 1995 they privatised Sumerbank (in the sample)\(^{163}\) and continued by Anadolu bank., Denizbank\(^{164}\) (both May 1997) and Etibank (1998)\(^{165}\). The two privatised state-owned banks included in the current study sample are Sumerbank and Etibank. Their privatisation process took place during financial instability period. Table 6-4-8 summarise the efficiency scores for both banks by year.

It is seen in the table that both banks experienced serious drops in efficiency levels post-crisis and post the privatisation. However, it is not easy to disentangle the impact of the two phenomena on the banks efficiency. It can be argued that the Turkish government gave little thought on the timing of privatisation.

---

\(^{163}\) Sold to the textile arm of the domestic family group Garipoglu for $103.5 million.

\(^{164}\) Andolu bank sold for $ 69.5 million and Deniz bank sold for $ 66 million.

\(^{165}\) Eti bank sold for $ 155 million.
During the 1990s whilst the Turkish government was experiencing high deficit and shortage of funds. They found it difficult to raise funds in the international market. Such circumstances were likely to force the government to sell the banks enable them to raise funds. However, the financial unrest which was as “fire under the ashes” soon prevailed causing further stress on the privatised state-owned banks, which most likely were not ready for competition.

6.4.4. The Parametric Productivity of the Turkish Banks

The present section investigates the productive progress of Turkish banks during the sample period. The proposed present Generalised Malmquist Total Factor Productivity Index (GMTFPI) by Orea (2002) is employed to measure the productivity growth. Further inspection of the sources of productivity growth is achieved by decomposing the index into its components, namely efficiency, technology and scale change indexes. This section further investigates the financial crisis and privatisation policy implication on the Turkish banks’ productivity growth. Also, it is of the current study interest to explore any variation in productivity growth and its components among different forms of banks’ ownership and sizes.

The parameters of the selected SFA model (M4a) are used to estimate the GMTFPI and further decompose it into its components Technical Efficiency Change (EC), Technological Change (TC) and Scale Efficiency Change (SEC) components. The SFA model (M4a)\textsuperscript{166} employed in the productivity analysis

\textsuperscript{166}Section () of the present study introduces a comprehensive justification for the choice of that particular model (M4a). The empirical result for Model four (M4a) is presented in table (6-4-6)
assumes that environmental and bank-specific variables affect the shape of production technology.

The first order coefficients of the input distance function can be interpreted as distance elasticities evaluated at the sample mean. Hence, the inputs and outputs variables are divided by its geometric mean. Furthermore, in order to impose homogeneity in inputs the fixed asset variable is used as a numerator. Table (6-4-6) depicts that all the first order coefficients are having the expected signs. Thus, implying that the input distance function is decreasing in inputs and increasing in outputs at the sample mean.

Table: 6-4-9 Monotonicity descriptive statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Obs</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
<th>Number of positives</th>
<th>Number of negatives</th>
<th>% of Wrong(+) sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Deposits</td>
<td>270</td>
<td>-0.36</td>
<td>0.30</td>
<td>-1.41</td>
<td>0.32</td>
<td>17</td>
<td>253</td>
<td>6.3%</td>
</tr>
<tr>
<td>Total Loans</td>
<td>270</td>
<td>-0.31</td>
<td>0.29</td>
<td>-1.02</td>
<td>0.73</td>
<td>39</td>
<td>231</td>
<td>14.44%</td>
</tr>
<tr>
<td>Other Income</td>
<td>270</td>
<td>-0.66</td>
<td>0.69</td>
<td>-2.54</td>
<td>0.44</td>
<td>30</td>
<td>240</td>
<td>11.11%</td>
</tr>
</tbody>
</table>

Scale elasticity

\[
\begin{align*}
\text{RTS} & = \sum_{s=1}^{1} \beta_{s} \\
\text{RTS} & = \left(1 / \sum_{s=1}^{1} \beta_{s}\right)
\end{align*}
\]

<table>
<thead>
<tr>
<th></th>
<th>Obs</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>Number of positives</th>
<th>Number of negatives</th>
<th>% of Wrong(+) sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTS (\sum_{s=1}^{1} \beta_{s})</td>
<td>270</td>
<td>-1.330</td>
<td>-3.317</td>
<td>-0.096</td>
<td>0*</td>
<td>270**</td>
<td>0.0%</td>
</tr>
<tr>
<td>RTS (\left(1 / \sum_{s=1}^{1} \beta_{s}\right))</td>
<td>270</td>
<td>1.033</td>
<td>0.868</td>
<td>0.301</td>
<td>10.398</td>
<td>0*</td>
<td>270**</td>
</tr>
</tbody>
</table>

Notes: ♣(more) ♣♣(less) than one in absolute value, ♠(less) ♠♠(more) than one in absolute value

Table 6-4-9 illustrates some descriptive statistics on the observations of the outputs elasticities and the scale elasticities (i.e. sum of output elasticities). The statistics reveal that monotonicity does not hold 100% for each observation for all output variables. It fails in 6.3%, 14.44% and 11.11% of deposits, loans and other income respectively. The output elasticities should be negative at every data point for the scale effect not to be biased (Orea, 2002:16-17).
Since the elasticities of all the outputs do not satisfy the conditions of unbiased scale effect in the current case, it is reasonably to surmise that the effect of economies of scale on productivity is, on average not accurately measured particularly in the data points (elasticities) that obtained wrong signs. Thereupon, these data points are ignored when computing the industry and groups scale efficiency change and consequently the GMTFPI. This procedure considers only the data points for which the monotonicity conditions are satisfied. Figure (6-4-5) illustrates the estimated productivity growth (GMTFPI) and its to decomposition to technical efficiency change (TECI), technological change (TCI) and Scale efficiency change (SECI)\textsuperscript{167} using the Orea (2002) models specification of the Generalised Malmquist index of total factor productivity. The banks experienced -17% average productivity regress during the sample period. A significant regress in technical efficiency (TECI) and scale efficiency (SECI) is –10%, -15% respectively on average during the sample period and has contributed to the productivity regress.

\textsuperscript{167} Note that the SEC is estimated using restricted elasticity approach to overcome the biases in output elasticities by only considering the correct signs elasticities.
The regress in TECI and SECI offsets the technological progress 28%. The graph also depicts that Turkish banks were concerned with the technology transfer hence, the significant improvement in the technological change. The Turkish banks were investing heavily in IT innovation and retail banking technologies (i.e. ATM machines) (Isik and Hassan, 2002). Moreover, it is postulated in pervious studies that the Turkish banks were suffering from scale efficiency regress in the early 1990s (El-Gamal and Inanoglu, 2005). However, it seems from figure 6-4-5 that Turkish banks utilised their scale more efficiently during the late 1990s. Despite the negative efficiency change the scale efficiency were converging since 1992 and heaved the convergence in productivity growth. Particularly from the year 1997 the results reveal positive scale efficiency (progress). The productivity progress started in 1996 caused by the recovered scale efficiency change and the relatively stable technological change.

The efficiency change maintained its declining trend however the high SEC and TC boosted the productivity. The patterns of efficiency, technological and scale efficiency change reflect the operating environment of the Turkish banks during the sample period. Moreover, the choice of production approach in this chapter has to a certain extent an effect on the empirical results. In early 1990s, many commercial banks have focused more in passing through borrowed funds from the international markets to the government in order to reap the high return in the government securities. The traditional banking activities seem to be relatively deserted at least during the early 1990s.
However, toward the mid 1990s particularly post the 1994 crisis it seems that the banks started to recognise their operational problem and adopted to the market condition post the financial crisis. This can be observed from the improvement in scale efficiency change. Since, the scale size is measured in inputs when adopting an output orientation whereas when adopting the input orientation the scale size is measured on the outputs (Thanassoulis, 2001). Consequently, the results suggests that the Turkish banks in general focused on the outputs side (deposits and loans) in the post crisis which in turn reflected in their improvement in scale efficiency and productivity growth overall.

6.4.4.1. Ownership, Size, and Bank’s Productivity

This section aims to shed light on the productivity performance of various forms of ownership and sizes. Table 6-4-10 summarises the geometric mean of the generalised Malmquist productivity index (GMTFPI) and its component (TEI, TCI and SECI) in index\textsuperscript{168} form. In general the state-owned bank outperformed the other forms of ownership in productivity growth (GMTPI=1.24).

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Obs</th>
<th>TECI</th>
<th>TCI</th>
<th>SECI</th>
<th>GMTFPI</th>
<th>GMTFP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>19</td>
<td>0.94</td>
<td>1.72</td>
<td>0.76</td>
<td>1.24</td>
<td>21%</td>
</tr>
<tr>
<td>Private</td>
<td>83</td>
<td>0.91</td>
<td>1.25</td>
<td>0.85</td>
<td>0.97</td>
<td>-4%</td>
</tr>
<tr>
<td>Foreign</td>
<td>14</td>
<td>0.90</td>
<td>1.31</td>
<td>0.95</td>
<td>1.11</td>
<td>11%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>31</td>
<td>0.89</td>
<td>1.26</td>
<td>0.86</td>
<td>0.96</td>
<td>-4%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>4</td>
<td>0.87</td>
<td>1.66</td>
<td>1.49</td>
<td>2.13</td>
<td>76%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size</th>
<th>Obs</th>
<th>TECI</th>
<th>TCI</th>
<th>SECI</th>
<th>GMTFPI</th>
<th>GMTFP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>19</td>
<td>0.92</td>
<td>1.90</td>
<td>0.75</td>
<td>1.31</td>
<td>27%</td>
</tr>
<tr>
<td>M</td>
<td>35</td>
<td>0.92</td>
<td>1.30</td>
<td>0.80</td>
<td>0.96</td>
<td>-4%</td>
</tr>
<tr>
<td>S</td>
<td>97</td>
<td>0.90</td>
<td>1.23</td>
<td>0.91</td>
<td>1.01</td>
<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td>0.90</td>
<td>1.32</td>
<td>0.86</td>
<td>0.85</td>
<td>-17%</td>
</tr>
</tbody>
</table>

\textsuperscript{168} Value <1 means regress, value >1 means progress.
The 35% cumulative average growth achieved by the state-owned banks mainly attributed to the rather huge (54%) outward shift in the production technology compared to others\(^{169}\) (TCI=1.72). All forms of ownership have experienced decreasing return to scale and operated rather inefficiently. In contrast, all forms of ownership experienced outward shift in technology. The state-owned banks tend to be the worst among other rivals in terms of scale efficiency regress. The foreign banks have the least scale efficiency regress. The technological progresses experienced by all banks’ ownership clusters are most likely due to the reduction of excessive branches and human resources. During the early 1990s the focus of the Turkish banks was toward acquiring technological infrastructure and highly qualified human capital. Also, some Turkish banks started to provide international banking services and expand overseas through own branches or subsidiaries (Isik and Hassan, 2002).

The large banks are the most productive compared to both medium and small size banks most of the banks included in the large banks size cluster are state-owned banks. Compared to small banks, medium banks seem to have better efforts to catching up with large size banks. However, efficiency regress is prevailing. The significant shift in the production technology of the large banks is the main contributor to the obtained productivity growth. Medium banks are the least efficient in utilising resources and scale.

\(^{169}\) The results of S_P_SDIF banks will not be considered in the analysis henceforth. The S_P_SDIF starts only from 1996, the years before 1996 is not included due to the wrong signs of elasticities see table 6-4-11.
6.4.4.2. Crisis implication on productivity growth

Table 6-4-11 summarise the average GMTFPI and its decompositions by ownership and size clusters over three sub-periods. During the pre-crisis period the most prevailing phenomenon is the substantial regress in scale efficiency change observed in all banks ownership and size clusters. The state-owned banks however, experience trivial productivity regress 1% mainly due to the substantial outward shift in the production technology.

Similarly, during pre-crisis period large size banks experience high technological progress. Both private and foreign banks mimicked each other performance in terms of technical efficiency change and technological change. However, the private banks have higher scale efficiency regress compared to the foreign banks scaled efficiency regress.

There are no significant discrepancies among different ownership forms in terms of the banks’ catching up efforts (i.e. technical efficiency change). P_SDIF banks obtain the second highest technological progress after the state-owned banks however these banks achieved the highest scale efficiency regress, consequently the highest productivity regress among other rivals. During the initial years of crisis the state-owned banks obtain higher levels of technological progress compared to the pre-crisis period.
Table: 6-4–11 GMTFPI and its components over sub-periods (by ownership and size)

<table>
<thead>
<tr>
<th>Ownership/Size</th>
<th>Obs</th>
<th>TECI</th>
<th>TCI</th>
<th>SECI</th>
<th>GMTFPI</th>
<th>GMTFP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-crisis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>8</td>
<td>0.95</td>
<td>1.66</td>
<td>0.64</td>
<td>1.01</td>
<td>1%</td>
</tr>
<tr>
<td>Private</td>
<td>22</td>
<td>0.94</td>
<td>1.09</td>
<td>0.59</td>
<td>0.61</td>
<td>-50%</td>
</tr>
<tr>
<td>Foreign</td>
<td>4</td>
<td>0.94</td>
<td>1.08</td>
<td>0.62</td>
<td>0.63</td>
<td>-47%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>7</td>
<td>0.93</td>
<td>1.11</td>
<td>0.55</td>
<td>0.56</td>
<td>-58%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
</tr>
<tr>
<td>Size L</td>
<td>8</td>
<td>0.94</td>
<td>1.74</td>
<td>0.63</td>
<td>1.03</td>
<td>3%</td>
</tr>
<tr>
<td>M</td>
<td>12</td>
<td>0.94</td>
<td>1.20</td>
<td>0.59</td>
<td>0.67</td>
<td>-40%</td>
</tr>
<tr>
<td>S</td>
<td>21</td>
<td>0.94</td>
<td>1.01</td>
<td>0.58</td>
<td>0.56</td>
<td>-59%</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>0.94</td>
<td>1.19</td>
<td>0.59</td>
<td>0.66</td>
<td>-41%</td>
</tr>
<tr>
<td>Crisis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>5</td>
<td>0.94</td>
<td>1.65</td>
<td>0.76</td>
<td>1.18</td>
<td>17%</td>
</tr>
<tr>
<td>Private</td>
<td>14</td>
<td>0.92</td>
<td>1.29</td>
<td>0.73</td>
<td>0.86</td>
<td>-15%</td>
</tr>
<tr>
<td>Foreign</td>
<td>3</td>
<td>0.90</td>
<td>1.38</td>
<td>0.79</td>
<td>0.98</td>
<td>-2%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>8</td>
<td>0.91</td>
<td>1.24</td>
<td>0.76</td>
<td>0.85</td>
<td>-16%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
</tr>
<tr>
<td>Size L</td>
<td>5</td>
<td>0.92</td>
<td>1.95</td>
<td>0.75</td>
<td>1.35</td>
<td>30%</td>
</tr>
<tr>
<td>M</td>
<td>9</td>
<td>0.93</td>
<td>1.30</td>
<td>0.74</td>
<td>0.89</td>
<td>-11%</td>
</tr>
<tr>
<td>S</td>
<td>16</td>
<td>0.91</td>
<td>1.21</td>
<td>0.75</td>
<td>0.83</td>
<td>-19%</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>0.92</td>
<td>1.34</td>
<td>0.75</td>
<td>0.92</td>
<td>-8%</td>
</tr>
<tr>
<td>Post-crisis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>6</td>
<td>0.94</td>
<td>1.87</td>
<td>0.96</td>
<td>1.69</td>
<td>52%</td>
</tr>
<tr>
<td>Private</td>
<td>47</td>
<td>0.89</td>
<td>1.32</td>
<td>1.06</td>
<td>1.24</td>
<td>21%</td>
</tr>
<tr>
<td>Foreign</td>
<td>7</td>
<td>0.87</td>
<td>1.44</td>
<td>1.30</td>
<td>1.64</td>
<td>49%</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>16</td>
<td>0.86</td>
<td>1.34</td>
<td>1.12</td>
<td>1.28</td>
<td>25%</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>4</td>
<td>0.87</td>
<td>1.66</td>
<td>1.49</td>
<td>2.13</td>
<td>76%</td>
</tr>
<tr>
<td>Size L</td>
<td>6</td>
<td>0.90</td>
<td>2.10</td>
<td>0.94</td>
<td>1.77</td>
<td>57%</td>
</tr>
<tr>
<td>M</td>
<td>14</td>
<td>0.90</td>
<td>1.40</td>
<td>1.09</td>
<td>1.37</td>
<td>32%</td>
</tr>
<tr>
<td>S</td>
<td>60</td>
<td>0.88</td>
<td>1.33</td>
<td>1.12</td>
<td>1.30</td>
<td>26%</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>0.88</td>
<td>1.39</td>
<td>1.10</td>
<td>1.34</td>
<td>30%</td>
</tr>
<tr>
<td>Sample period</td>
<td>151</td>
<td>0.90</td>
<td>1.32</td>
<td>0.86</td>
<td>0.85</td>
<td>-17%</td>
</tr>
</tbody>
</table>

Technological progress was the main contributor to the 17% in productivity growth in the state-owned banks. The other ownership clusters achieve productivity regress originated mainly from the significant scale efficiency regress. During the post-crisis years all ownership and size clusters experience substantial growth in technology. The state-owned banks have the highest outward shift in technology TCI (1.87) and the private banks have the lowest TCI.
Post-crisis period foreign, private and P_SDIF experience significant scale efficiency progress of 1.30, 1.06 and 1.12 respectively. The substantial technological and scale efficiency progress contributed to impressive productivity growth of 49% for the foreign banks.

The state-owned banks achieve the highest productivity growth of 52% attributed mainly to the rather impressive technological progress, which offsets the slight regress in technical and scale efficiency. The Turkish banks expanded in technology updates during the early 1990s this is reflected in significant up-ward shift in the production frontier (Isik and Hassan, 2002). However, the substantial scale efficiency regress offsets the technological progress and resulted in productivity regress pre- and during the crisis period. Post-crisis except the state-owned banks, the other ownership clusters experienced significant growth in the output side reflected in scale efficiency progress (expansion in the production technology), and productivity progress. The privatised banks namely Sumerbank and Etibank productivity progress is not available. Hence, these two banks encompass wrong signs elasticity in most of the years.
6.5. Conclusion

The present chapter aimed to investigate the performance of the Turkish banks during the post-liberalisation period (1991-2000). In this period Turkey has experienced two crises, the first was in the year 1994, and the second was at the end of the year 2000. In between the two crises, the Turkish government embarked a stabilisation program, which aimed to control the sour inflation rate. The banking sector experienced disintermediation resulted from deserting the traditional banking production activities (loans and deposits) by the private banks. Private banks expanded foreign borrowing and passed it through to the Turkish government via the purchasing of government securities and taking advantage of the higher interest rates on government securities.

Two methodologies were employed to estimate the efficiency and productivity of the Turkish banks namely, the non-parametric linear programming DEA and the parametric stochastic, SFA. The technical efficiency scores obtained using both methodologies and the productivity growth are estimated using the Malmquist productivity index by following FGNZ (1994) DEA-based estimation as well as Orea (2002)’s SFA-based estimation.

Both non-parametric and parametric empirical results show that the Turkish banks have experienced efficiency regress during the sample period. The Turkish banks however, have had mixed productivity performance during the sample period. The State-owned banks achieved the highest level of average efficiency. The SDIF banks are the least efficient as expected. Consequently the large banks are the most efficient compared to medium and small banks. The efficiency levels
seems to diminish at decreasing rate post-crisis period in all banks however SDIF banks experienced faster rate which lead to a wider efficiency gap between them and the best practice banks.

Both methods suggest productivity regress on average during the sample periods. However, the productivity regress in the parametric estimation, −17% is higher than the non-parametric, −4.4%. The discrepancies between the two methods are expected given the differences in the underlying assumption of the two estimated Malmquist indexes. The parametric method shows productivity regress pre- and during the crisis period stem mainly from scale efficiency regress. During the post-crisis period a reveres pattern depicted in the scale efficiency change resulted in significant productivity growth. In contrast the non-parametric method shows productivity growth pre-crisis however, post- and during crisis years productivity regress took place attributed to scale efficiency change.

On the other hand, both methods show that the state-owned banks are the most productive and the P _SDIF banks are the least productive. Similarly the large banks are the most productive in both methods. The parametric shows the medium size banks the least productive. In contrast the non-parametric shows the small banks the least productive.
7. Chapter seven: Comparison between Non-parametric and Parametric Results

7.1. Introduction

This thesis employs two prominent methodologies, namely, DEA and SFA which represent non-parametric and parametric techniques respectively. Both are widely used methodological approaches that have gained significant popularity in the measurement of firm’s efficiency and productivity measurement. The comparison between the efficiency and productivity estimations generated from the two methodologies employed in this thesis is far from easy. The different assumptions underlying each methodology make a comparison almost infeasible. Nonetheless, this chapter aims to provide comparison between the results obtained. Furthermore, the chapter attempts to explain any consistency or discrepancy found in the obtained results from the two methods.

The use of two different methodologies is motivated by three reasons. First, in the last two decades efficiency and productivity studies have investigated whether one approach is better than the other. So far the literature has not reached a consensus on which method should be preferred. Second, according to Charnes, Cooper, and Sueyoshi (1988), Learmer and Leonard (1983), and Learmer (1994) an environment with diverse or extreme conditions resembles the beneficial milieu for evaluating models. Hence, using different approaches to investigate the economic phenomenon is an appraisable procedure to crosscheck the robustness of the results obtained from alternative models. Third, the appropriateness of a
given approach depends on the distribution of the data set. Providing that the true level of an institution’s efficiency is often unknown, using both techniques diminishes the potential bias that might exist due to the distributional assumption of the data set.

The sample period satisfies such suggestion hence it is sufficiently long and characterised by changing regulatory and market conditions. Despite that, underlying assumptions imposed on the data set vary between each method. There is a similarity in the models using the underlying techniques (i.e. non-parametric and parametric). Consequently, previous studies suggest that applying alternative models should make little difference in the empirical results [see Berger and Humphrey (1997), Berger and Mester (1997), and Bauer et al (1998)]

### 7.2. Previous studies

The empirical studies in measuring bank performance are vast in the academic literature. However, few of these attempts to apply two or more techniques to an identical data set. Among others see Resti (1997), Bauer et al. (1998) Casu and Girardone (2002) Casu et al (2004), Weill (2004), and Becalli et al. (2006), which applied parametric and not parametric methods.

Resti (1997) analyses the cost efficiency of the Italian banks during the period 1988-1992. The study applied both parametric and stochastic techniques on a data sample of 270 banks. In this study there is no substantial difference between the SFA based ranks and the DEA based ranks. Nevertheless, the study finds that
SFA produces higher efficiency scores compared to the DEA method. Moreover, there is moderate and statistically significant rank correlation between the two methods (44%-58%). Both methods tend to provide strong rank correlation over time. However, DEA seems more persistent compared to SFA.

Bauer et al. (1998) examine the consistency of the results obtained from different frontier methods namely DEA, SFA, TFA and DFA. The authors imply that a frontier method is usable if it roughly provides the same information as other common used methods. Bauer et al (1998) note that one should consider the DEA results with more vigilance. Hence, under DEA efficiency levels may be sensitive to “self-identifiers” or “near self-identifiers” when there are two few observations relative to the number of inputs, outputs, and constraints in DEA.

The study proposed six consistency conditions, which assists in analysing the robustness of frontier efficiency measures their conditions mainly focused on the following aspects. First, comparison between SFA and DEA efficiency scores distributions; second, the rank order correlation of the efficiency distributions; third, identification of first and worst practice firms by both methods; fourth, the stability of the measured efficiency over time; fifth, consistency of the estimated efficiency with market competitive market conditions; and six, consistency with standard non-frontier conditions. The study finds substantially weak rank-order correlation between the non-parametric and parametric methods. Each of these aspects will be elaborated later in this chapter.

\[^{170}\text{That is some firms may be self-identified as 100\% efficient not because they dominate any other firms, but simply because no other firms or linear combination of firms are comparable in some many dimensions. Similarly, other firms may be measured as 100\% efficiency because there are only few a few other observations with which they are comparable (Bauer et al. 1998).}\]
Moreover, although both methods show stability over time, DEA tend to be rather stable compared to other methodologies. The authors argue that in general there is no consensus to suggest which approach correctly specifies the efficient frontier. Finally Bauer et al. (1998) recommends that the cross-checks among methodologies are important to ensure that policy makers are aware of different information embedded in efficiency measures obtained from alternative methods.

Casu and Girardone (2002) estimate the cost and profit frontier of the Italian financial conglomerates during the 1990s. The study employs SFA, DFA and DEA to estimate both cost and profit efficiency scores. The study finds similarity between in efficiency range and variance among the adopted methods. Nevertheless, the DEA based cost efficiency scores seem volatile compared to the SFA estimates, which demonstrate sustainable upward trend in efficiency scores. In the study the DFA estimates adopted a declining trend over time efficiency estimates. Nonetheless, it seems to be more consistent with the DEA efficiency rather than the SFA ones.

Weill (2004) investigates the robustness of SFA, DFA and DEA. The study applies the three methods on a sample of European banks from five different countries over the period from 1992-1998. The results reveal insignificant difference in efficiency score among the adopted techniques and there is a positive correlation between SFA and DFA. In contrast to Casu and Girardone findings, the study finds no positive relation between the efficiency scores obtained by DFA and the ones obtained by DEA methods. Furthermore, the
comparison between the efficiency scores uniformity with the standard performance measures (i.e. financial ratios) implies significant correlation.

Casu et al. (2004) examine whether the non-parametric and parametric productivity growth estimation would yield similar results. The study employs FGNZ (1994) DEA based Malmquist total factor productivity index as well as Berger and Mester (1999, 2001) approach to estimate parametric productivity growth from stochastic cost function (SFC). The study applies two methodologies on a data sample for the large banks from the largest European countries during the period 1994-2000. The study compares between technical efficiency change (DEA) and inefficiency change (SFC) in addition the trends in technological change (DEA) and change in best practice (SFC). The study however, provides visual comparison is presented using illustrative graphs rather than employing any statistical technique. The findings of the study surmise that the competing methodologies (i.e. SFA and DEA approaches) in this vein do not yield markedly different results. Hence, both methodologies are successful in identifying the major drivers of productivity growth.

Becalli et al. (2006) explores the relationship between the banks’ efficiency and stock return. The study employs both the SFA and the DEA to estimate the cost efficiency of a sample of European banks listed in the stock exchange in the years 1999 and 2000. The study finds that the stock prices tend to closely mirror the pattern of the cost efficiency change obtained from DEA method rather the ones obtained from SFA. Moreover, the DEA are slightly lower than the SFA scores however a higher dispersion is shown in the DEA efficiency scores.
Fiorentino et al. (2006) investigates the consistency of the cost efficiency scores obtained from DEA and SFA. The data set encompasses all the German Universal banks during the period 1993-2004. The paper followed the six consistency conditions proposed by Bauer et al (1998). The results reveal very low consistency between SFA and DEA measures particularly when applied to the entire panel sample. The SFA generates considerably higher average cost efficiency compared to the DEA method. The discrepancies between the mean cost efficiency obtained from both methods tend to diminish when stratifying the sample data to year, banking group or both.

The study reveals higher improvement in the DEA results hence suggests that the DEA is highly sensitive to heterogeneity. The analysis demonstrates low, however positive rank-order correlation between the two methods. A high stability of efficiency ranking overtime is observed in both methodologies and the two methodologies are not successful in identifying the extreme performers consistently. Finally the study finds weak correlation between the efficiency measures and the traditional non-frontier performance measures,
7.3. Methodology

Most of the aforementioned studies employed Spearman Rank correlation to investigate the consistency between the two methodologies. This thesis employs Spearman rank correlation, and also exploits the flexibility of Kendall rank correlation and finally reports both. Kendall tau correlation coefficient is equivalent to Spearman R with regard to the underlying assumptions. It is also comparable in terms of its statistical power. However, Spearman R and Kendall tau are usually not identical in magnitude because of their underlying logic as well as their computational formulas are different [See Seigel and Castellan, (1988) for the relationship between the two coefficients171]

Kendall tau and Spearman R imply different interpretations, Spearman R can be thought of as the regular Pearson product moment correlation coefficient except that Spearman R is computed from ranks. Kendall tau, on the other hand represents the probability that in the observed data the two variables are in the same order (ranks) versus the two variables are in different orders. Hence, there is flexibility of Kendall ranks correlation in terms of explaining the results (Kendall and Gibson, 1990), (Hill and Lewicki, 2006) and (Sheskin, 2004).

In the spirit of Bauer et al. (1998: 3) this thesis aim to compare between the efficiency scores obtained from both methodologies namely the non-parametric DEA and the parametric SFA. The consistency between the SFA and DEA

\[ -1 \leq 3 \times Kendall\tau - 2 \times SpearmanR \leq 1 \]
methodologies is examined by using the results obtained from chapter five and six. However due to the non-availability of comparable non-frontier performance measures in both samples (i.e. Egyptian and Turkish data), this thesis is only concerned to test Bauer et al. (1998) consistency conditions from one to five.

Bauer et al (1998) suggests six consistency conditions:

First: The efficiency scores generated by the different approaches should have comparable means, standard deviations, and other distributional prosperities.

Second: The different approaches should rank the institutions in the approximately the same order.

Third: The different approaches should identify mostly the same institutions a best practice and as worth practice.

Fourth: All the useful approaches should demonstrate reasonable stability over time, i.e. tend to consistently identify the same institution as relatively efficient or inefficient in different year, rather than varying markedly from one year to the next.

Fifth: The efficiency scores generated by different approaches should be reasonably consistent with competitive conditions in the market

Six: The measured efficiency from all of the useful approaches should be reasonably consistent with standard non-frontier performance measures, such as return on assets and or the cost/revenue ratio.”
7.4. Statistic tools

7.4.1. Spearman’s Rank Correlation Coefficient: \([\text{Rho} \rho]\)

It is non-parametric measure of rank-order correlation between two ranked variables. The Spearman’s Rank correlation does neither require making a priori assumptions about the frequency distribution nor the assumption of linear relationship between the tested variables. Furthermore it is a satisfactory measure for testing the null hypothesis of no relationship and does not require the variables to be measured in on interval or ration scale. Nevertheless, the main drawback of the Spearman’s Rank Correlation is that it is difficult to interpret as a measure of the strength of the relationship.

\[
\rho = \frac{\sum (R_{SFA_i} - \overline{R}_{SFA}) (R_{DEA_i} - \overline{R}_{DEA})}{\sqrt{\sum (R_{SFA_i} - \overline{R}_{SFA})^2 \sum (R_{DEA_i} - \overline{R}_{DEA})^2}}
\]

Hypothesis:

\[H_0 : \rho = 0\] (There is no correlation between the ranked pairs)

\[H_1 : \rho \neq 0\] (The ranked pairs are correlated)

The statistical significance of the Spearman’s \(\rho\) coefficient is tests by the t-test, at significance level 5%.

7.4.2. Kendall’s Rank Correlation Coefficients: \([\tau_a \& \tau_b]\)

Kendall-tau is a non-parametric rank-order which provides a distribution free test of independence (i.e. no assumption of distribution). However unlike Spearman’s Rank Correlation it provides a measure of the strength of dependence between two variables. Hence, it materialises the superiority of Kendall’s tau correlation over the Spearman’s rank in terms of flexibility to interpret results (Kendall and
Gibson, 1990). Kendall’s coefficients have much simpler algebraic structure compared to the Spearman coefficient. Moreover, another characteristic of Kendall’s simplicity is that it can be computed directly from the actual observations without the need of converting it to ranks.

Consider two samples, in our case SFA and DEA\textsuperscript{172}, each of size \(n\). The total number of possible pairing of SFA and DEA observations is \(n(n-1)/2\). For example: after ordering the pairs (i.e. efficiency scores) by SFA values and DEA values. If the estimated efficiency scores for bank (i) in year (t) from both methodologies are \((SFA_{it}, DEA_{it})\) and \((SFA_{jt}, DEA_{jt})\) are a pair of “bivariate” observations.

- \textit{concordant} if \([\text{sign}_{(SFA_{it}-SFA_{jt})}\pm = \text{sign}_{(DEA_{it}-DEA_{jt})}\pm]\)
- \textit{discordant} if \([\text{sign}_{(SFA_{it}-SFA_{jt})}\pm \neq \text{sign}_{(DEA_{it}-DEA_{jt})}\pm]\)

Consequently Kendall’s coefficients:

\[
\tau = \frac{n_c - n_d}{n(n-1)/2}
\]

Where:

\(n\) : is the number of observations,

\(n_c\) : is the number of concordant pairs (ordered in the same way)

\(n_d\) : is the number of discordant pairs (ordered differently)

In case of the existence of tied (same valued) observations then \(\tau_b\)

\textsuperscript{172} The two samples of efficiency scores obtained from SFA and DEA methods.
$$\tau_b = \frac{S}{\sqrt{\frac{n(n-1)}{2} - \sum_{i=1}^{n} t_i (t_i - 1)/2}}$$

Where:

$t_i$ is the number of observations tied at a particular rank of SFA scores

$u_i$ is the number of observations tied at a particular rank of DEA scores

$s = (n_c - n_d)$ is the difference between the number of concordant and discordant pairs.

**Interpretation of Kendall’s coefficients**

If $\tau_a$ and/or $\tau_b = 1 \therefore$ There is perfect agreement between the two rankings

If $\tau_a$ and/or $\tau_b = -1 \therefore$ There is perfect disagreement between the two rankings

If $\tau_a$ and/or $\tau_b = 0 \therefore$ The two rankings are independent

If $\tau_a$ and/or $\tau_b = -1 \leftrightarrow 1 \therefore$ The increasing values towards each direction imply increasing agreement/disagreement between ranking if 1 or −1 respectively.

**Hypothesis:**

$H_0 : \tau_{a,b} = 0$ (There is no correlation between the ranked pairs)

$H_1 : \tau_{a,b} \neq 0$ (The ranked pairs are correlated)

The statistical significance of the Kendall’s coefficient $\tau_{a,b}$ is tests by the Z-test, at significance level 5%.
7.5. Data:

The analysis of consistency will be conducted on the estimated efficiency scores obtained from the Egyptian data (chapter five) and the Turkish data (chapter six). First the ranks of SFA and DEA efficiency scores are obtained for each bank relative to the efficiency levels of the sample within each year. This procedure is applied to each data set and the analysis of consistency is conducted for each data set separately. The Egyptian sample contains twenty-five banks over nineteen years (i.e. 475 observations). The Turkish sample contains twenty-seven banks over ten years (i.e. 27 observations).

The following tables summarises the descriptive statistics of the SFA and DEA technical efficiency scores:

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Egypt SFA</th>
<th>Egypt DEA</th>
<th>Turkey SFA</th>
<th>Turkey DEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.51</td>
<td>0.86</td>
<td>0.53</td>
<td>0.80</td>
</tr>
<tr>
<td>Max</td>
<td>0.97</td>
<td>1.00</td>
<td>0.93</td>
<td>1.00</td>
</tr>
<tr>
<td>Min</td>
<td>0.06</td>
<td>0.31</td>
<td>0.09</td>
<td>0.18</td>
</tr>
<tr>
<td>Median</td>
<td>0.51</td>
<td>1.00</td>
<td>0.54</td>
<td>0.97</td>
</tr>
<tr>
<td>Standard deviation (sd)</td>
<td>0.19</td>
<td>0.19</td>
<td>0.20</td>
<td>0.24</td>
</tr>
<tr>
<td>Variance</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.21</td>
<td>-1.19</td>
<td>-0.11</td>
<td>-0.84</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.74</td>
<td>3.13</td>
<td>2.13</td>
<td>2.37</td>
</tr>
<tr>
<td>Number of obs</td>
<td>475</td>
<td></td>
<td>270</td>
<td></td>
</tr>
<tr>
<td>Spearman's rho</td>
<td>0.51</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test of Ho: SFA and DEA efficiency are independent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob &gt; t^2%</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kendall’s tau-a</td>
<td>0.30</td>
<td>0.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kendall’s tau-b</td>
<td>0.36</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob &gt; z^2%</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

173 Since the SFA (IDF) is a curved productivity function similar to DEA-VRS where economies of scale are not considered to be relevant for efficiency (C. von Hirschhausen, 2006). therefore, it would be appropriate to focus on DEA VRS for comparison.
7.6. Empirical results

7.6.1. Condition one: Comparability of means and standard deviation

Table (7-3-1) presents the descriptive statistics for the estimated efficiency scores under the two employed methodologies SFA and DEA for both Egyptian and Turkish data. The statistics reveal the discrepancies between the SFA and DEA estimated efficiencies in terms of the mean efficiency in both countries results. Unlike previous inter alia Resti (1997), Bauer et al (1998) and Fiorentino et al. (2006) the results in this thesis reveals that the DEA mean efficiency is much higher than the SFA mean efficiency scores during the sample period. For instance Egypt has $(0.86)_{\text{DEA}}, (0.51)_{\text{SFA}}$ and Turkey has $(0.80)_{\text{DEA}}, (0.53)_{\text{SFA}}$. These results are expected given the underlying assumptions for each model. On the other hand, when the dispersion measures namely standard deviation and variance for SFA and DEA efficiency score are compared it seems to provide close results in the Egyptian case. However, slight difference is obtained in the Turkish banks.

It is worth noting that in order to test the mean or variance equality using further robust statistical analysis is not applicable in this vein. For instance employing the classical two-sample tests will not be of any statistical meaning. The two-sample tests procedures encompasses a vital assumption, that the distribution of each of the sample means follows the normal distributions, such assumption is
not valid in the current case. The inefficiency estimated using SFA\(^{174}\) follows truncated normal distribution and that does not statistically ensure that the technical efficiency\(^{175}\) will be consequently normally distributed. In contrast, there is no underlying assumption of normal distribution of the DEA technical efficiency scores. Thereupon, the comparison between the two efficiency scores means (SFA and DEA) can only be described, as one is higher than the other.

7.6.2. Condition two: Ranking Similarity

The rank order correlation test presented in table 7-3-1 used the panel estimation of efficiency scores (SFA vs DEA) from the two data sets (Egypt and Turkey). In the Egyptian case, the Spearman rank correlation between the rankings of the two methodologies reveals slight moderate correlation coefficient (\(\rho_{\text{Egy}} = 0.51\)). However, the Turkish data reveals slightly low rho (\(\rho_{\text{Trk}} = 0.36\)). In both cases the coefficients are statistically significant at 5% level. The Spearman rank as aforementioned is not flexible and implies that there is a relationship between the pairs’ ranks (i.e. SFA and DEA) ranks. The Kendall correlation coefficients estimated for the ranks of Egyptian data efficiency scores confirm the existence of relationship between the two SFA and DEA ranks. For instance (\(\tau_{\text{Egy}} = 0.30\)) suggests low probability of concordance between SFA and DEA ranking.

\(^{174}\)\(\mu_k \sim \text{iid }N(\mu, \sigma^2)\) \{truncated normal\}

\(^{175}\)\(TE_a = \exp^{-\eta_a}\)
On the other hand ($\tau^E_b = 0.36$) suggests slightly higher probability of concordance between the two methodologies ranks. In the case of Turkish data Kendall ranks correlation coefficients ($\tau^Dk_a = 0.23$) and ($\tau^Dk_b = 0.28$) imply relatively lower levels of concordance between the ranks from the two methodologies.

### 7.6.2.1. Cross-section Ranking Similarity (Egypt)

In order to impose more robust analysis, this study extends Bauer et al (1998) by further investigating the ranks-correlation between each bank during the sample period (i.e. cross-section inspection). Table 7-4-1 summarises the SFA and DEA mean efficiency scores over the sample period and the rank of each bank according to each methodology. Furthermore, both the Spearman and Kendall ranks correlation coefficients are calculated for each bank and presented in the same table to provide more insight to the investigation of the relationship between the estimates obtained from the two methodologies. The Spearman rank correlation implies very weak relationship between DEA and SFA ranking on bank basis. Out of twenty-five banks there are seven banks, which experience considerably low negative however, insignificant relationship between the two methodologies ranking. Moreover, there are three banks with no relationship. The remaining fifteen banks obtained low positive rho (weak correlation) and they are all statistically insignificant.$^{177}$

---

$^{176}$ Makes adjustment for ties (i.e. concordance observations).

$^{177}$ The insignificance is likely owed to the low degrees of freedom.
Table: 7–4– 1 SFA and DEA efficiency rank by bank (Egypt)

<table>
<thead>
<tr>
<th>Bank</th>
<th>Obs</th>
<th>Kendall's tau-a</th>
<th>Kendall's tau-b</th>
<th>Spearman's rho</th>
<th>Mean (SFA)</th>
<th>Mean Rank (SFA)</th>
<th>Mean (DEA)</th>
<th>Mean Rank (DEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>19</td>
<td>0.0351</td>
<td>0.1245</td>
<td>0.6281</td>
<td>0.137</td>
<td>0.5759</td>
<td>0.46</td>
<td>14</td>
</tr>
<tr>
<td>AFIB</td>
<td>19</td>
<td>-0.076</td>
<td>-0.1722</td>
<td>0.4564</td>
<td>-0.185</td>
<td>0.4487</td>
<td>0.65</td>
<td>4</td>
</tr>
<tr>
<td>AIBC</td>
<td>19</td>
<td>0.193</td>
<td>0.2515</td>
<td>0.2022</td>
<td>0.320</td>
<td>0.1821</td>
<td>0.38</td>
<td>21</td>
</tr>
<tr>
<td>AMCB</td>
<td>19</td>
<td>-0.0058</td>
<td>-0.009</td>
<td>0.019</td>
<td>0.9389</td>
<td>0.44</td>
<td>0.44</td>
<td>16</td>
</tr>
<tr>
<td>AUB</td>
<td>19</td>
<td>0.2164</td>
<td>0.2848</td>
<td>0.153</td>
<td>0.343</td>
<td>0.1509</td>
<td>0.23</td>
<td>25</td>
</tr>
<tr>
<td>B Misr</td>
<td>19</td>
<td>-0.0643</td>
<td>-0.2343</td>
<td>0.3509</td>
<td>-0.241</td>
<td>0.3208</td>
<td>0.56</td>
<td>8</td>
</tr>
<tr>
<td>BNP</td>
<td>19</td>
<td>-0.0234</td>
<td>-0.1169</td>
<td>0.7008</td>
<td>-0.121</td>
<td>0.6224</td>
<td>0.95</td>
<td>13</td>
</tr>
<tr>
<td>Barclays</td>
<td>19</td>
<td>0.0819</td>
<td>0.274</td>
<td>0.2249</td>
<td>0.308</td>
<td>0.1994</td>
<td>0.49</td>
<td>6</td>
</tr>
</tbody>
</table>

The Kendall ranks correlation coefficients tau-a and tau-b assert the Spearman rank correlation test findings. Hence, the Kendall coefficients suggest low probability of concordance between SFA and DEA ranking on bank basis and they are not statistically significant in all the cases. Out of twenty-five banks there are four banks suggesting no relationship between the SFA and DEA ranks, both Kendall and Spearman’s Rank coefficients provide same evidence no relationship.
7.6.2.2. Cross-section Ranking Similarity (Turkey)

Table 7-4-2 summarises the SFA and DEA average efficiency by banks, the ranks of average efficiency by bank, the results of association in non-parametric tests

<table>
<thead>
<tr>
<th>Bank</th>
<th>Obs</th>
<th>Kendall's tau-a</th>
<th>Kendall's tau-b</th>
<th>Spearman's rho</th>
<th>Prob &gt; z</th>
<th>Mean (SFA)</th>
<th>Mean Rank (SFA)</th>
<th>Mean (DEA)</th>
<th>Mean Rank (DEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ziraat</td>
<td>10</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.85</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Emlak</td>
<td>10</td>
<td>0.02</td>
<td>0.03</td>
<td>1.00</td>
<td>0.05</td>
<td>0.31</td>
<td>20</td>
<td>0.93</td>
<td>5</td>
</tr>
<tr>
<td>Halk</td>
<td>10</td>
<td>-0.16</td>
<td>-0.57</td>
<td>0.14</td>
<td>-0.58</td>
<td>0.70</td>
<td>5</td>
<td>0.95</td>
<td>4</td>
</tr>
<tr>
<td>Vakiflar</td>
<td>10</td>
<td>0.27</td>
<td>0.37</td>
<td>0.24</td>
<td>0.42</td>
<td>0.55</td>
<td>9</td>
<td>0.86</td>
<td>8</td>
</tr>
<tr>
<td>BTKB</td>
<td>10</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.71</td>
<td>4</td>
<td>0.95</td>
<td>4</td>
</tr>
<tr>
<td>Demirbank</td>
<td>10</td>
<td>0.38</td>
<td>0.47</td>
<td>0.11</td>
<td>0.56</td>
<td>0.41</td>
<td>14</td>
<td>0.65</td>
<td>16</td>
</tr>
<tr>
<td>Egebank</td>
<td>10</td>
<td>-0.13</td>
<td>-0.18</td>
<td>0.60</td>
<td>-0.18</td>
<td>0.52</td>
<td>11</td>
<td>0.68</td>
<td>15</td>
</tr>
<tr>
<td>Esbank</td>
<td>10</td>
<td>-0.16</td>
<td>-0.19</td>
<td>0.55</td>
<td>-0.24</td>
<td>0.41</td>
<td>14</td>
<td>0.57</td>
<td>20</td>
</tr>
<tr>
<td>EtiBank</td>
<td>10</td>
<td>0.38</td>
<td>0.45</td>
<td>0.12</td>
<td>0.53</td>
<td>0.39</td>
<td>16</td>
<td>0.70</td>
<td>13</td>
</tr>
<tr>
<td>Finansbank</td>
<td>10</td>
<td>0.07</td>
<td>0.11</td>
<td>0.81</td>
<td>0.12</td>
<td>0.52</td>
<td>11</td>
<td>0.90</td>
<td>6</td>
</tr>
<tr>
<td>Interbank</td>
<td>10</td>
<td>-0.20</td>
<td>-0.49</td>
<td>0.15</td>
<td>-0.54</td>
<td>0.65</td>
<td>6</td>
<td>0.82</td>
<td>9</td>
</tr>
<tr>
<td>Iktisat</td>
<td>10</td>
<td>0.11</td>
<td>0.15</td>
<td>0.68</td>
<td>0.13</td>
<td>0.54</td>
<td>10</td>
<td>0.74</td>
<td>10</td>
</tr>
<tr>
<td>Kochbank</td>
<td>10</td>
<td>0.04</td>
<td>0.05</td>
<td>0.92</td>
<td>0.06</td>
<td>0.47</td>
<td>13</td>
<td>0.71</td>
<td>12</td>
</tr>
<tr>
<td>Oyakbank</td>
<td>10</td>
<td>-0.11</td>
<td>-0.33</td>
<td>0.42</td>
<td>-0.33</td>
<td>0.61</td>
<td>8</td>
<td>1.00</td>
<td>1</td>
</tr>
<tr>
<td>Pamukbank</td>
<td>10</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.62</td>
<td>7</td>
<td>1.00</td>
<td>1</td>
</tr>
<tr>
<td>Sumerbank</td>
<td>10</td>
<td>0.31</td>
<td>0.41</td>
<td>0.18</td>
<td>0.48</td>
<td>0.49</td>
<td>12</td>
<td>0.69</td>
<td>14</td>
</tr>
<tr>
<td>Secerbank</td>
<td>10</td>
<td>0.07</td>
<td>0.08</td>
<td>0.85</td>
<td>0.10</td>
<td>0.38</td>
<td>17</td>
<td>0.49</td>
<td>21</td>
</tr>
<tr>
<td>Textilbank</td>
<td>10</td>
<td>0.11</td>
<td>0.15</td>
<td>0.68</td>
<td>0.18</td>
<td>0.55</td>
<td>9</td>
<td>0.73</td>
<td>11</td>
</tr>
<tr>
<td>Disbank</td>
<td>10</td>
<td>-0.20</td>
<td>-0.24</td>
<td>0.44</td>
<td>-0.30</td>
<td>0.40</td>
<td>15</td>
<td>0.68</td>
<td>15</td>
</tr>
<tr>
<td>Tekonbank</td>
<td>10</td>
<td>0.20</td>
<td>0.25</td>
<td>0.43</td>
<td>0.29</td>
<td>0.41</td>
<td>14</td>
<td>0.64</td>
<td>17</td>
</tr>
<tr>
<td>Turkbank</td>
<td>10</td>
<td>0.31</td>
<td>0.36</td>
<td>0.22</td>
<td>0.44</td>
<td>0.37</td>
<td>18</td>
<td>0.63</td>
<td>18</td>
</tr>
<tr>
<td>Garanti</td>
<td>10</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.84</td>
<td>2</td>
<td>0.93</td>
<td>5</td>
</tr>
<tr>
<td>Imarbank</td>
<td>10</td>
<td>-0.09</td>
<td>-0.16</td>
<td>0.69</td>
<td>-0.17</td>
<td>0.37</td>
<td>18</td>
<td>0.96</td>
<td>3</td>
</tr>
<tr>
<td>IsBank</td>
<td>10</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.77</td>
<td>3</td>
<td>0.88</td>
<td>7</td>
</tr>
<tr>
<td>Yasarbank</td>
<td>10</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.40</td>
<td>15</td>
<td>1.00</td>
<td>1</td>
</tr>
<tr>
<td>ArapTurk</td>
<td>10</td>
<td>-0.07</td>
<td>-0.15</td>
<td>0.76</td>
<td>-0.15</td>
<td>0.65</td>
<td>6</td>
<td>0.97</td>
<td>2</td>
</tr>
<tr>
<td>Osmanli</td>
<td>10</td>
<td>0.22</td>
<td>0.25</td>
<td>0.40</td>
<td>0.23</td>
<td>0.36</td>
<td>19</td>
<td>0.60</td>
<td>19</td>
</tr>
</tbody>
</table>

(i.e. Spearman’s rank and Kendall’s correlation coefficients). The Spearman rank and Kendall’s tau correlation coefficients imply very weak relationship and weak concordance between DEA and SFA ranking on bank basis respectively.

According to both tests, among twenty-seven banks there are seven banks with no relationship, another seven banks with considerably low negative however, insignificant relationship at 10% level. In contrast, there are four banks with slightly moderate positive correlation and probabilities of concordance.
Nevertheless all are statistically insignificant in all cases at 10% level. The remaining nine banks obtain low positive rho (i.e. weak correlation) and low probabilities of concordance are also revealed by Kendall’s coefficients tau-a and tau-b. All are statistically insignificant at 10% level.

7.6.3. Condition three: Same identification of best and worst practice banks

The percentile statistics for efficiency scores and ranks\(^{178}\) obtained from each method and within each country data set are summarised in table 7-4-3. The statistics in the table imply that unlike the SFA method the DEA high efficiency scores tend to be concentrated starting mid percentile level (i.e. Median). On the other hand, the SFA high efficiency scores are likely concentrated in the upper level percentile.

These results reflect vital characteristics of the efficiency scores obtained from the two methodologies. The SFA technical efficiency tends to be normally distributed (i.e. Median=Mode=Mean). In contrast the DEA efficiency scores are negatively skewed, hence the DEA tends to locate more banks on the best practice frontier relative to the SFA method.

\(^{178}\) Note: The ranking percentile is in reverse orders (i.e. the higher efficiency ranked 1) to fit with efficiency percentile.
Table 7-4-3 SFA and DEA Efficiency and Ranking by percentile

<table>
<thead>
<tr>
<th>Stats</th>
<th>SFA</th>
<th>SFA Rank</th>
<th>DEA</th>
<th>DEA Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p1</td>
<td>0.12</td>
<td>22</td>
<td>0.34</td>
<td>17</td>
</tr>
<tr>
<td>p10</td>
<td>0.26</td>
<td>20</td>
<td>0.54</td>
<td>14</td>
</tr>
<tr>
<td>p25</td>
<td>0.38</td>
<td>19</td>
<td>0.73</td>
<td>12</td>
</tr>
<tr>
<td>p50</td>
<td>0.51</td>
<td>16</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>p75</td>
<td>0.64</td>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>p90</td>
<td>0.74</td>
<td>7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>p95</td>
<td>0.85</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>p99</td>
<td>0.97</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Turkey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p1</td>
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Different underlying assumptions in both methodologies and the calculation procedures of efficiency scores followed by each methodology play a vital role in such distribution. The statistics summarised in the tables 7-4-3 and 7-3-1 provides signals that the two methodologies might presume weak consistency in ranking either the best or weak practice firms. Nevertheless, it is essential to conduct further statistical tests to examine whether the two methodologies are consistent in identifying the most and the least efficient bank(s) by employing the ranking correlation techniques.

Table 7-4-4 summarises the ranking correlation between the SFA and DEA ranks classified by percentile. The correlation coefficients are calculated between the two methodologies ranking of best practice and worst practice top 25 (i.e. 75 percentile) and bottom 25 (i.e. 25 percentile) respectively. Both Spearman and Kendall correlation coefficients fail to suggest consistency between DEA and
SFA in distinguishing the best and worst practice both Egyptian and Turkish data coincide with the same results. In the case of Egypt the least 25% efficient banks’ ranking are correlated with the Spearman Rho 0.21 and significant at 90% level. This implies weak consistency between the two methods. Similarly, Kendall tau-a and Kendall tau-b assert very weak concordance in ranking the worst practice banks.

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<th>Turkey p25</th>
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<tr>
<td>Kendall tau-b</td>
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<tr>
<td>Z</td>
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</table>

On the other hand, both Spearman and Kendall rank correlation coefficients could not find any relationship between DEA and SFA ranking for the best practice. Likewise, the analysis of Turkish data efficiency scores ranks reveals that both DEA and SFA are not consistent in detecting either the best or the worst practice banks. Bauer et al. (1998)\(^{179}\) and Fiorentino et al. (2006) found that the two approaches are not consistent in determining the best practice and the worst practice firm.

### 7.6.4. Condition four: stability over time

According to Bauer et al. (1998) it is least likely to find the performance of banks, which varies significantly at least within two successive years. However, some banks might experience improvement or deterioration in their performance over

\(^{179}\) For the best practice the Spearman rank correlation between SFA and DEA range is (0.3 → 0.36) however, for the worst practice it range is (0.29→0.368) [See Bauer et al (1998) Appendix table 4]
short time period. In order to examine the year-to-year stability of the DEA and SFA efficiency estimates, both the Spearman’s and Kendall rank correlation coefficients are calculated for each method between each pair of years. The between years Spearman’s rank correlation coefficients are presented for both Egypt and Turkey in tables 7-3-6 and 7-3-7 respectively. The SFA estimates are presented in the lower triangle of the table. The upper triangle represents the year-to-year DEA ranks correlation.

For the Egyptian data the Spearman’s rank shows high correlation (all significant at 95% level) in the SFA ranking over the year with exception of the year 1984 estimates and the rest of the sample period years, which reveal low correlation between the ranks in rest of the years. Nevertheless, the SFA Spearman ranking correlation remains high and statistically significant over the sample period. Kendall coefficients (tau-a, tau-b)\(^\text{180}\) assert the concordance of ranking year to year hence, confirming the stability of SFA ranking over time.

Similar results are obtained from the Spearman’s rank correlation applied on SFA efficiency scores of Turkish banks. The results reveal significant positive relationship between the ranks over years, which imply consistency of the SFA ranking over years. Similarly the Kendall coefficients (tau-a, tau-b)\(^\text{181}\) suggest high probabilities of concordance between the SFA ranks over years particularly over short-term period. However, over long-term periods the probability of

\(^{180}\) See Appendix (12) tables (1) and (2) for Kendall tau-a and tau-b rank correlation DEA and SFA respectively [Egypt].

\(^{181}\) See Appendix (12) tables (3) and (4) for Kendall tau-a and tau-b rank correlation DEA and SFA respectively [Turkey].
concordance slightly decreases but remains in moderate significant correlation coefficient.

In contrast the DEA rank consistency test for the Egyptian results fails to prove stability over time. There are recurring incidents of negative correlation year to year. More over, most of the time the relation is insignificant which implies weak or no relationship by Spearman’s rank and low probabilities of concordance by Kendall’s tau coefficients. On the other hand, the Turkish data seems to provide moderate evidence of DEA ranks consistency over time. The Spearman’s coefficient in most of the years suggests significant relationship between the ranks. The short-term period tend to have more significant rho. Similarly, Kendall’s tau coefficients assert the phenomenon and suggest moderate levels of probabilities of concordance between the DEA ranks over years.

7.6.5. Condition five: consistency with competitive conditions

Bauer et al. (1998) argue that the SFA method provides higher level of average efficiency concurrently during deregulation period. Consequently the authors suggest that SFA is more consistent (i.e. more responsive and reflect the environmental condition) with market and competitive conditions. Hence, it provides evidence of improved efficiency levels during deregulation.

Bauer et al. (1998) based their judgement on the fact the SFA average efficiency is higher than DEA average efficiency scores. Moreover, the authors argued that because DEA does not count for random errors, the average efficiency tend to be
considerably low. The efficiency scores tend to be higher than technical efficiency scores in general because they are based on cost function (i.e. economic efficiency). Bauer et al. (1998) explains that DEA might have obtained lower levels of efficiency compared to SFA because DEA does not count for error term. Consequently the dispersion from random error would likely result in lower average efficiency. The underlying assumptions of the SFA (net of environmental variables) estimated efficiency scores in this thesis are different\textsuperscript{182} from the SFA estimates in Bauer et al. (1998). In contrast DEA estimates could be described as gross of both environmental variables and data noise (i.e. error term). Comparing the outcome of the two methods using average efficiency to investigate the consistency with competitive condition might not be appropriate in this case. The ample differences between the underlying assumptions of the two methodologies cannot be ignored. Thus, this thesis sees Bauer et al. (1998) proposed consistency condition in this vein is highly debatable. Hence, both SFA and DEA efficiency levels improved post-liberalisation Egyptian case but the SFA average efficiency scores are lower than the DEA ones. Suggesting DEA is more consistent with market condition because it provides higher average efficiency scores compared to the SFA results is questionable. Consequently, this thesis suggests further investigation in this condition.

\textsuperscript{182} The SFA efficiency estimated assumes that the environmental variables have direct influence on the production structure. In other words it is assumed that each firm faces different production frontier. Consequently the technical efficiency obtained is net of environmental influences (Coelli, Perelman and Romano, 1999).
<table>
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Table: 7–4–6 Spearman Rank Correlation SFA Ranks and DEA Ranks [Turkey]

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<td>0.2979</td>
<td>0.3408</td>
<td>0.5237*</td>
<td>0.3980*</td>
<td>0.5054*</td>
<td>0.3449</td>
<td>0.0716</td>
<td>1992</td>
</tr>
<tr>
<td>1993</td>
<td>1</td>
<td>1</td>
<td>0.241</td>
<td>0.3463</td>
<td>0.3889*</td>
<td>0.2749</td>
<td>0.4231*</td>
<td>0.3205</td>
<td>0.1761</td>
<td>1993</td>
</tr>
<tr>
<td>1994</td>
<td>1</td>
<td>0.3491</td>
<td>0.1943</td>
<td>0.2254</td>
<td>0.1114</td>
<td>0.0244</td>
<td>-0.1827</td>
<td>1994</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>1</td>
<td>0.5312*</td>
<td>0.6244*</td>
<td>0.4527*</td>
<td>0.4895*</td>
<td>0.4323*</td>
<td>1995</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>1</td>
<td>0.7299*</td>
<td>0.7588*</td>
<td>0.4371*</td>
<td>0.3044</td>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>1</td>
<td>0.8603*</td>
<td>0.6369*</td>
<td>0.5373*</td>
<td>1997</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>1</td>
<td>0.5955*</td>
<td>0.4375*</td>
<td>1998</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>1</td>
<td>0.6900*</td>
<td>1999</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1</td>
<td>0.6900*</td>
<td>1999</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * indicates statistical significance at the 0.05 level.
The analysis in this chapter extends Bauer et al. (1998) approach and suggests additional tests for the discrepancies between the average efficiency pre- and post-reform periods for each method. Simple statistical procedures could be handful in the analysis. The relative change in the coefficient of variation (CCV)\textsuperscript{183} of the efficiency scores is used to test the assumption that during more liberal environment banks performance tends to improve compared to the efficiency during less liberal period.

The efficiency scores’ coefficient of variation\textsuperscript{184} is obtained by dividing the standard deviation of efficiency scores during each sub-period by the average efficiency scores for the same period. The underlying assumptions of such test are: First, improvement in efficiency stimulated by more liberal environment will increase the average efficiency and consequently improve the CV (lower). Second, the more liberal environment would tend to stimulate more banks to catch-up with best practice frontier. This in turn will lead to a lower standard deviation of the efficiency scores and consequently will lead to a lower coefficient of variation.

This further analysis might shed more light on whether both methods were consistent in responding to market conditions. The alternative is to find that only one of the methods has responded to the competitive environment.

\begin{align*}
\text{CCV} &= \left( \frac{CV_{t+1}}{CV_t} \right) - 1 \\
\text{CV}_{\sigma} &= \frac{\sigma}{X_{\sigma}}
\end{align*}
The statistics summarised in table 7-4-7 reveals that overall DEA average efficiency (0.86) is higher than SFA average efficiency (0.51). Similarly, the sub-period statistics reveal that DEA efficiency levels tend to be higher than SFA efficiency scores.

<table>
<thead>
<tr>
<th>Stat/Period</th>
<th>Overall</th>
<th>Pre-liberalisation</th>
<th>Post-liberalisation</th>
<th>Post-privatisation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SFA</td>
<td>DEA</td>
<td>SFA</td>
<td>DEA</td>
</tr>
<tr>
<td>Mean</td>
<td>0.51</td>
<td>0.86</td>
<td>0.39</td>
<td>0.79</td>
</tr>
<tr>
<td>SD</td>
<td>0.19</td>
<td>0.19</td>
<td>0.18</td>
<td>0.22</td>
</tr>
<tr>
<td>CV</td>
<td>0.37</td>
<td>0.22</td>
<td>0.46</td>
<td>0.28</td>
</tr>
<tr>
<td>CCV</td>
<td>-32.0%</td>
<td>-36.9%</td>
<td>-34.2%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Max</td>
<td>0.97</td>
<td>1</td>
<td>0.94</td>
<td>1</td>
</tr>
<tr>
<td>Min</td>
<td>0.06</td>
<td>0.31</td>
<td>0.06</td>
<td>0.31</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.21</td>
<td>-1.19</td>
<td>1.12</td>
<td>-0.38</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.74</td>
<td>3.13</td>
<td>4.55</td>
<td>1.63</td>
</tr>
</tbody>
</table>

Following the argument of Bauer et al. (1998) it seems that the DEA is more responsive to the competition conditions compared to the SFA efficiency scores. However, the present analysis finds the basis of such conclusion is subject to reservation.

It can be argued that simple statistical methods can be employed to investigate the proposed consistency condition. The proposed relative change in efficiency scores’ coefficient of variation (CCV) reveals that overall the SFA seems to be more responsive. Nevertheless, the DEA method showed lower CCV (i.e. more response) in the initial liberalisation period. The SFA CCV seems to be relatively low in the second stage of liberalisation (i.e. privatisation). In contrast the DEA CCV tends to provide positive change, which reflects higher dispersion in efficiency relative to
average efficiency. Consequently, it can be argued that the SFA efficiency scores were more responsive to the market conditions.

In the case of the Turkish banks test investigated whether the SFA score were more responsive to the financial crisis (i.e. unfavourable economic conditions) compared to the DEA efficiency. The expectation is entirely different compared to the Egyptian case. Hence, in the Turkish case we expect the CCV to increase during crisis period (i.e. efficiency regress and more dispersion of banks from the best practice frontier)

| Table 7–4- 8 Comparison between SFA and DEA scores during sub-periods [Turkey] |
|---------------------------------|-----------------|---------|---------|---------|--------|---------|
| stat/period                     | Overall         | Pre-crisis | Crisis  | Post-crisis |
|                                 | SFA  | DEA  | SFA  | DEA  | SFA  | DEA  | SFA  | DEA  |
| Mean                           | 0.53 | 0.80 | 0.69 | 0.83 | 0.58 | 0.85 | 0.41 | 0.76 |
| SD                             | 0.20 | 0.24 | 0.12 | 0.21 | 0.15 | 0.19 | 0.19 | 0.27 |
| CV                             | 0.39 | 0.30 | 0.18 | 0.25 | 0.26 | 0.23 | 0.46 | 0.35 |
| CCV                            |       |       | 44.4%| -7.7%| 80.5%| 54.5%|
| Max                            | 0.93 | 1.00 | 0.93 | 1.00 | 0.89 | 1.00 | 0.85 | 1.00 |
| Min                            | 0.09 | 0.18 | 0.44 | 0.33 | 0.33 | 0.29 | 0.09 | 0.18 |
| Skewness                       | -0.11 | -0.84 | 0.23 | -0.83 | 0.43 | -1.09 | 0.51 | -0.63 |
| Kurtosis                       | 2.13 | 2.37 | 2.11 | 2.38 | 2.16 | 3.28 | 2.39 | 1.86 |

The SFA CCV of the relative performance between crisis and pre-crisis periods is positive and relatively high (44%) implying decrease in average efficiency and higher dispersion between the sub-periods’ average efficiency levels (i.e. increase in standard deviation). In contrast the DEA CCV implies improvement on average efficiency relative to the dispersion in efficiency during the initial crisis period compared to the pre-crisis period. The results confirm that the SFA efficiency score were more responsive to the crisis effect (market condition) compared to the DEA efficiency scores.
7.7. Extension to Bauer et al. (1998) consistency conditions

The present chapter proposes to introduce another two conditions as an extension to Bauer et al. (1998) work to be considered in testing the consistency between the results obtained from parametric and non-parametric methodologies. These two conditions aim to address the heterogeneity of bank groups in the sample. The heterogeneity in banking institutions could emerge because of different regions (rural, urban), banking specialisation (saving, commercial, and cooperative) ownership (state, private and foreign), and size (large, medium, and small).

Nevertheless, this thesis has adopted a careful approach in choosing the sample banks in both Egypt and Turkey by focusing on commercial banks (bank group homogeneity). The present thesis however, counts for various sources heterogeneity in the parametric estimation of technical efficiency by incorporating bank specific variables directly in the input distance function.\(^{185}\)

Since it is also of the interest of this thesis to test whether the SFA and DEA efficiency ranks would differ in between the banks ownership and size strata, the following conditions are proposed to provide more insight to the comparison between the results obtained from SFA and DEA methodologies.

The first condition is the consistency of the two methods in ranking bank groups (i.e. ownership, size). Hence, frequent recommendations are observed in the recent development in literature of the necessity to differentiate between the performances.

\(^{185}\) For more details, see chapter four.
of banks’ groups within the industry [see Isik and Hassan (2002) and Berger and Humphrey (1997)]. The second condition suggests testing the two methodologies’ consistency of ranking banks during sub-periods (periods of economic reform). As continuity to Bauer et al. (1998) the present section will extend the notion of “six conditions” and use “condition seven” and “condition eight” for the proposed additional conditions.

Condition seven: aims to compare the consistency between the two methodologies in terms of ranking banks groups. This approach aims to consider the heterogenous nature of banking institutions in comparing the efficiency scores ranks from the two methodologies. Similar to condition two, both Spearman and Kendall rank correlation are employed to test the consistency of ranks within banks group strata (i.e. ownership and size).

Condition eight: tests the consistency between the two methodologies in ranking banks within sub-periods (i.e. periods of changes in economic environment). The sub-periods are similar to the ones used in the empirical chapters five and six. For the Egyptian data there are three sub-periods, pre-liberalisation, post-liberalisation (first-stage of reform) and finally post-privatisation (second stage of reform). On the other hand for the Turkish data the total sample period is divided into three sub-periods, namely pre-crisis, crisis (initial effect) and post-crisis (long-term effect)
7.7.1. Proposed condition seven (consistency with ranking bank groups) “Does heterogeneity matters?”

Table 7-5-1 summarises the Spearman’s rho ranks correlation coefficient and the Kendall’s ranks correlation coefficients (tau-a and tau-b) for both ownership and size strata for the Egyptian and Turkish banks. The results obtained aim to test the consistency of the two methodologies in ranking banks within homogenous groups of banks’ ownership and size.

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Egypt</th>
<th>Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spearman's Rank</td>
<td>Kendall's Coefficients</td>
</tr>
<tr>
<td></td>
<td>Obs</td>
<td>Rho</td>
</tr>
<tr>
<td>State</td>
<td>76</td>
<td>0.10</td>
</tr>
<tr>
<td>Private</td>
<td>57</td>
<td>0.04</td>
</tr>
<tr>
<td>Foreign</td>
<td>19</td>
<td>0.00</td>
</tr>
<tr>
<td>JV</td>
<td>19</td>
<td>0.20</td>
</tr>
<tr>
<td>JV_TF</td>
<td>95</td>
<td>0.43</td>
</tr>
<tr>
<td>JV_TP</td>
<td>19</td>
<td>0.34</td>
</tr>
<tr>
<td>P_TF</td>
<td>20</td>
<td>0.24</td>
</tr>
<tr>
<td>P_SDIF</td>
<td>20</td>
<td>-0.09</td>
</tr>
<tr>
<td>S_P_SDIF</td>
<td>50</td>
<td>-0.09</td>
</tr>
</tbody>
</table>

The correlations coefficients summarised here above provide mixed results in the terms of the consistency of the two methodologies, SFA and DEA in ranking banks within particular bank’s group strata. For instance, in the Egyptian case there are relatively moderate and statistically significant (at 1% level) probabilities of concordance shown between SFA and DEA ranking of JV-TF and JV-TP. In
contrast, other forms of banks’ ownership groups provide statistically insignificant low probability of concordance, particularly in the state, private and P_TF banks.

The foreign banks test reveals no relationship between the rankings of the two methodologies. These results imply that another factor of heterogeneity is likely to have the upper hand in comparing the two methodologies efficiency scores within ownership strata. The ranking consistency test of banks within the size strata simply supports the previous suggestion. Hence, the ranks correlation coefficient improves when comparing SFA and DEA ranks within size strata. The Kendall’s rank correlation coefficients suggest relatively higher probabilities of concordance all are statistically significant at 1% level.

To further clarify the implication of the test, the state-owned banks and private banks show insignificant low probability of concordance when comparing the SFA and DEA efficiency scores ranking. The state-owned banks are the largest banks in the sample and consequently all are included in the large bank size strata along with another private bank. Nevertheless when testing the consistency between the rankings within the large size strata a relatively high and statistically significant high probability of concordance emerges. This results imply that the ownership heterogeneity is prevailing in the efficiency cores results and consequently on the efficiency ranks.

Thus it is necessary to consider the effect of heterogeneity while analysing the banking institutions (El-Gamal and Inanoglu, 2005). Since the parametric methods
allow counting for heterogeneity in the model either as inefficiency effect or in shaping the production technology it tends to provide more reliable results to the policy makers in that vein. Consequently comparing the efficiency results between the non-parametric and parametric efficiency estimates is likely to reveal discrepancies in ranking between the two methods in particular if the parametric model counts for heterogeneity, which is the case in this thesis. The analysis of the Turkish data provides similar results. The ranks correlation coefficients provide mixed levels of the probability of concordance between SFA and DEA ranks within the ownership strata. The state-owned, private and foreign banks reveal significant relatively moderate levels of concordance. In contrast the S_P_SDIF and P_SDIF banks group imply inconsistency between SFA and DEA in efficiency scores ranking within these particular strata classification.

In contrast within the size strata the large size banks test shows insignificant low probability of concordance between SFA and DEA ranking. This result features interesting implication hence, it is simply the other way around compared to the Egyptian case. In the Turkish banks the size heterogeneity is more prevailing in the Turkish data. Thereupon it is sensibly to argue that within heterogeneous sample it is likely to find discrepancies in ranking between the non-parametric and parametric efficiency estimates particularly if the parametric model counts for heterogeneity.
7.7.2. Proposed condition eight (consistency in ranking banks within sub-periods) “Is counting for economic environment changes matters?”

The purpose of this section is to investigate whether SFA and DEA will be consistent in efficiency ranking of banks during periods characterised of changes in the economic environment. The Egyptian sample period is divided into the three sub-periods pre-liberalisation (1984-1990), post-liberalisation (1991-1995) and post-privatisation (1996-2002). On the other hand the Turkish sample period is divided to three sub-periods namely pre-crisis (1991-1993), crisis (1994-1995) and post-crisis (1996-2000). Table 7-5-2 summarises the Spearman’s Rho rank-correlation coefficient as well as Kendall’s rank-correlation coefficient for both Egypt and Turkey, SFA and DEA efficiency ranks.

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Period</th>
<th>Obs</th>
<th>Spearman's Rank</th>
<th>Kendall's Rank</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Egypt</td>
<td>Turkey</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All period</td>
<td>475</td>
<td>0.51</td>
<td>0.00</td>
<td>0.30</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>Pre-liberalisation (P1)</td>
<td>175</td>
<td>0.68</td>
<td>0.00</td>
<td>0.47</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>Post-liberalisation (P2)</td>
<td>125</td>
<td>0.34</td>
<td>0.00</td>
<td>0.20</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>Post-privatisation (P3)</td>
<td>175</td>
<td>0.33</td>
<td>0.00</td>
<td>0.21</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>All period</td>
<td>270</td>
<td>0.36</td>
<td>0.00</td>
<td>0.23</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>Pre-crisis (P1)</td>
<td>81</td>
<td>0.16</td>
<td>0.17</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Crisis (P2)</td>
<td>54</td>
<td>0.34</td>
<td>0.01</td>
<td>0.22</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>Post-crisis (P3)</td>
<td>135</td>
<td>0.46</td>
<td>0.00</td>
<td>0.30</td>
<td>0.35</td>
</tr>
</tbody>
</table>
7.7.2.1. The hypothesis to be tested here:

Hypothesis: SFA and DEA are consistent in ranking banks within sub-periods. The null hypothesis \( H_0 \) there is consistency within sub-periods (i.e. \( \rho_{p_1} \approx \rho_{p_2} \approx \rho_{p_3} \) and \( \tau_{p_1} \approx \tau_{p_2} \approx \tau_{p_3} \)).

The alternative hypothesis \( H_a \) is that there is no consistency of ranking during sub-period. This test can achieved by comparing the correlation coefficients between the sub-periods in case of high discrepancies between the sub-periods’ correlation coefficient the null hypothesis is rejected otherwise fails to reject.

The Egyptian case: Reject the null hypothesis

The Turkish case: Reject the null hypothesis

This result confirms that SFA and DEA methods are not consistent in ranking banks in terms of efficiency scores over time as well as sub-periods. Three reasons are likely to cause such inconsistency. The first is modelling related and the second is related to model specification. The third however is associated indirectly to the heterogeneity in the two samples banks. With respect to the modelling dimension, the model used to estimate the stochastic frontiers is input-distance function. The translog form of the model incorporates time variables \( t \) and \( t^2 \) to capture the shifts in the production technology (i.e. technological change). The inclusions of time effect variables directly affect the error \( \nu \) component of the input distance function and consequently indirectly alter the inefficiency component \( \mu \) (Kumbhakar and Lovell, 2002). Consequently the estimated technical efficiency from SFA panel model is most likely to encompass time effect however, the time effect is generalised to all the banks in the sample.
On the other hand, DEA efficiency estimation does not consider the effect of time hence the estimation of efficiency is obtained year by year (Coelli, 1996).

Considering the model specification dimension in both Egypt and Turkey cases, the SFA model specification assumes that environmental variable and bank specific variables (heterogeneity control) affect the shape of the production technology. The trueness of the SFA models’ specifications is tested using nested models approach proposed by Coelli, Perelman and Romano (1999). The incorporation of environmental variables directly into the input distance function alter the efficiency score hence, according to Coelli, Perelman and Romano (1999) the technical efficiency score obtained from such model specification are net of environmental and bank specific variables. In contrast the DEA model estimated efficiency scores are gross of environmental and bank specific variables in addition to the data noise.

Finally the third reason, which could be related to the second reason, is the heterogeneity effect embedded in the sample banks in the two cases. For instance Molyneux et al. (1997) elucidate that escalated heterogeneity across banks owed to the increasing wave of deregulation policies. Moreover, banks mergers and foreign banks acquisition tend to further elevate the heterogeneity across the banks. Consequently, it is likely to observe inconsistency between SFA and DEA efficiency scores. Hence, in contrast to SFA, the DEA method as a benchmarking methodology does not count for random error and model sources of heterogeneity in addition to its sensitivity to outliers.
7.8. Conclusion

This chapter compared the results obtained from the parametric SFA and non-parametric DEA efficiency estimations. The analysis adopted Bauer et al. (1998) consistency conditions, and further introduced two analysis tools to examine the consistency between the parametric and non-parametric estimates. Kendall rank correlation was neglected by the efficiency analysis literature, which has been focusing on the Spearman rank correlation. Kendall correlation is more flexible and suitable for small data sets hence its result (tau-a and tau-b) is easier to explain compared to Spearman (Rho).

Moreover, this chapter suggested two additional conditions to test the consistency of the methods with competitive conditions by comparing the average efficiency obtained from the two methods between sub-periods of environmental reform (i.e. variables affecting competition and market conditions). The results of analysis reveal that SFA and DEA did not provide comparable means or standard deviation. Hence, the underlying assumptions of both models are entirely different. The obtained SFA efficiency is net of environmental variables whereas the DEA efficiency is considered gross of both environmental and bank specific variables effect and standard error.

SFA and DEA are inconsistent in ranking banks. Spearman rho implies moderate correlation and the Kendall coefficients provide lower probability of concordance between the efficiency ranking of the two methodologies on average. On bank
basis both Spearman and Kendall rank correlation suggested very low level of consistency between DEA and SFA. Furthermore, DEA and SFA failed to identify the worst practice bank. However, a low correlation and low probability of concordance appears in detecting the best practice by Spearman and Kendall rank correlation respectively.

The parametric method seemed to present strong evidence of stability over time. Spearman Rho and Kendall correlation reflect high correlation and high probability of concordance between the banks ranking over time in SFA estimates. In contrast DEA showed instability over time. Furthermore comparing the SFA and DEA ranking within banks groups and during sub-periods tend to be quiet appealing idea. This approach aimed to understand the effect of heterogeneity across banks groups on the consistency of the two methodologies ranking. The results implied that SFA and DEA tend to be inconsistent in ranking banks within groups hence DEA did not count for heterogeneity effect. Similar result is emerged when the consistency of the two methodologies in ranking banks during sub-periods (i.e. periods of economic changes) were compared.

Finally, The findings of the present chapter suggests that comparing DEA and SFA scores to investigate the consistency of the two methodologies is likely to be far from simplicity. In particular with data samples that encompasses heterogeneous banks. Moreover, analysing the banking system within periods of economic changes (i.e. liberalisation, deregulation or even financial crisis) imposes further difficulty on the comparison between the two methods results. In this vein the
bench marking method that counts for heterogeneity, error component and relatively insensitive to outliers is most likely to provide more reliable results and implications for policy makers.
8. Chapter eight: Conclusion

This chapter provides a summary of the empirical findings obtained in the pursuance of answering the thesis research questions. This thesis applied two prominent methodologies namely Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to estimate the efficiency and productivity of two emerging economies. Moreover, the results obtained are used to provide empirical comparison between the SFA and DEA estimates. To my best knowledge, this thesis is the first banking application of stochastic models which uses environmental and bank-specific variables that could affect the shape of the production technology. The thesis also extends the scant studies in banking performance literature which employs both parametric and non-parametric methods to analyse two countries data sets. Also, the thesis is the first in the frontier analysis literature to exploit the flexibility of Kendall’s rank correlation coefficient compared to the popularly used Spearman’s rank correlation in the comparison of the consistency between the SFA and DEA efficiency scores ranks. This chapter organised as follow, the following section summarises the findings obtained from the three empirical chapters. The subsequent section provides some policy implications. Finally, the chapter ends with limitations and recommendations of future research.
8.1. Empirical Findings

The measurement of bank performance in Egypt during the pre- and post liberalisation periods shows that the Egyptian banks efficiency levels improved in the post-liberalisation period. This result is similarly suggested by both DEA and SFA methods. Both methods however, provided different average of efficiency owed to the different underlying assumptions of the models. The parametric empirical results suggest that environmental and banks-specific variables affect the shape of the production technology in the case of Egyptian banks.

The adopted approach of dividing the sample period into three sub-periods reveals that the Egyptian banks have a significant response to liberalisation policies as the first round of reform. However, the second round of policy reforms represented in privatisation did not have significant impact on improving banks performance. In general the state-owned large banks tend to be the most efficient compared to other ownership and size clusters. This result implies that size matters and reflects the engraved cultural perception of the Egyptian households that state-owned banks are more trust-worthy compared to other bank categories.

In terms of productivity the Egyptian banks productivity improved in the post-liberalisation period. The main driver of productivity growth is rather significant improvement in scale efficiency change concurrently with relatively moderate efficiency growth. These two components offset the inward shift in production technology experienced over the years implying that Egyptian banks are still
learning by doing. The state-owned large banks are more productive compared to other ownership and size clusters. The financial liberalisation in Egypt tends to create gainers and losers. The foreign and privatised banks seem to be the most benefited ones from liberalisation and privatisation policies.

The Turkish banking system experienced significant disintermediation during the sample period. This is confirmed by obtaining wrong monotonicity signs when applying the intermediation approach in the SFA models. Consequently, this directed the study to employ the production approach as an alternative approach. Similar to Egyptian banks, the parametric model specification tests suggest that environmental and banks-specific variables affect the shape of the production technology of the Turkish banks rather the variability in average inefficiency.

The Turkish banks experienced significant efficiency regress during the financial disruption period. The results are confirmed by the estimated technical efficiency from both parametric and non-parametric methods. The state-owned large banks seem to be most efficient compared to other ownership and size clusters. In other words, the state-banks are financially solid to confront the waves of financial turbulence. Similar to Egypt, in this vein the culture aspect played important role hence the house-holds in Turkey found the state-owned banks more trust-worthy to deposit their savings as last resort after gold and foreign currency compilation. The SDIF banks are the least efficient as expected. Consequently the large banks are the most efficient compared to medium and small banks. The efficiency levels seem to diminish at decreasing rate post-crisis period in all banks however SDIF banks
experience faster rate which leads to a wider efficiency gap between them and the best practice banks.

The parametric method shows productivity regress pre- and during the crisis period, which stems mainly from scale efficiency regress. During the post-crisis period a reverse pattern is observed in the scale efficiency change, which in turn results in significant productivity growth. In contrary, the non-parametric method shows productivity growth pre-crisis however, post- and during crisis year productivity regress is attributed to the regress in scale efficiency. The discrepancies between the two methods are expected given the differences in the underlying assumption of the two estimated Malmquist indexes.

Both parametric and non-parametric methods assert that the state-owned banks are the most productive and the P_SDIF banks are the least productive. Similarly the large banks are the most productive compared to other size clusters. The Turkish banks expanded in technology updates during the early 1990s which is reflected in significant up-ward shift in the production frontier (Isik and Hassan, 2002). However, the substantial scale efficiency regress offsets the technological progress and results in productivity regress pre- and during the crisis period. In post-crisis period, except the state-owned banks, the rest of other ownership clusters experiences significant growth in the output side, reflected in scale efficiency progress (expansion in the production technology), and productivity progress.
The SFA and DEA estimated efficiency scores did not provide comparable means or standard deviation. The SFA and DEA results are inconsistent in ranking the banks. The Spearman rho implies moderate correlation whereas the Kendall coefficients provide lower probability of concordance between the efficiency rankings. The SFA and DEA failed to identify the worst practice banks. However, a low correlation and low probability of concordance appears in detecting the best practice by Spearman and Kendall rank correlation respectively.

The SFA provides strong evidence of stability over time in terms of efficiency scores. In contrast DEA showed instability over time. However, comparing the SFA and DEA ranking within banks groups and during sub-periods tend to be quiet appealing idea. This approach aimed to understand the effect of heterogeneity across banks groups on the consistency of the two methodologies ranking. The SFA and DEA are inconsistent in ranking banks within groups hence DEA did not count for heterogeneity effect. Similar result is emerged when testing the consistency of banks ranking during sub-periods (i.e. periods of economic changes).

This thesis finds that comparing DEA and SFA scores to investigate the consistency of the two methodologies is likely to be far from simplicity. The difficulty of such procedure augments within data samples that encompass heterogeneous banks. Also, periods of economic changes (i.e. liberalisation, deregulation or even financial crisis) tend to further augment the heterogeneity effect among the banks in the industry (Molyneux et al., 1997). This adds more complexity on the comparison between the SFA and DEA results. In this vein the
benchmarking method that counts for heterogeneity, error component and relatively insensitive to outliers is most likely to provide more reliable results and implications for policy makers (Bos et al., 2005).

8.2. Policy implications

The policy implications demonstrate that the Egyptian government succeeded to navigate through the liberalisation period without exposing the economy to any financial crisis. This achievement owes to the cautious and gradual implementation of liberalising the financial sector in Egypt. However, further investigation on this vein demonstrates that the government drifted from controlling the momentum of liberalisation and plunged into slow-down syndrome. The slow-down of liberalisation implementation affected the performance of the Egyptian banks in the long run, particularly in the post-privatisation period (i.e. second stage of reforms). For instance, Parker and Kirkpatrick (2005) suggest that one of the reasons of that privatisation have had mixed effects in developing countries is the lack of healthy regulatory and economic environment post-privatisation. Another explanation to the disappointing performance post-liberalisation is the high competition between the banks emerged post-privatisation (La Porta and Lopez-de-Silanes, 1997). On the other hand, the expeditious implementation of liberalisation policies by the Turkish government caused the financial turbulence and unstable economy status in the subsequent years. The absence of structured financial sector and lack of prudent regulations assist the spread of financial instability among the financial market
participants particularly the banking institutions. Thereupon, such circumstances collectively paved the way to the occurrence of the financial crisis.

On the other hand, on the micro level, the banking industry suffered the following non-exhaustive reasons: lack of experienced banks’ management, old technology, overstaffing, excessive branches, market segmentation, and government intervention in directing credit facilities. Such combination of exogenous and endogenous variables might have had the perfect formulae to harm the banking sector performance overall or individual banks in particular. Hence, the Turkish banks were not ready or neither being prepared, nor the government created a healthier regulatory environment to mitigate the negative impact of unfavourable economic shocks on the operating banks.

The unfavourable experience of bank privatisation reflects the situation of the Turkish economy during that period. The Turkish government was overwhelmed with the deficit in current accounts and the shortage of funds. Consequently, in despair to raise funds the government took an expeditious bank privatisation decision as an alternative source of finance. The privatised banks overpowered by the sector financial fragility. The crisis seems have affected their performance and small banks seem the most fragile to financial crisis. These results coincide with the notion commonly known in the literature “too-big-to-fail”. Moreover, it is hard to disentangle the effect of privatisation from the effect of crisis in investigating the privatised banks performance.
On the other hand, foreign banks do not necessarily perform better compared to the state-owned and private banks. In both Egypt and Turkey, the state-owned banks are the most productive and most efficient ones compared to other ownership clusters. I argue that in both countries the legacy of the previously repressed system still affects the performance of the banks in the industry. Moreover, besides the spread branch network advantage of the state-owned banks in both countries, the customer culture plays a vital role in the market segmentation.

The households in both countries seem to prefer state-owned banks compared to other ownership clusters as a depository houses. Lack of prudent regulations and governance rules in both banking sectors encourages high net-worth individuals to seek funding facilities from state-owned banks. This phenomenon is highly complex in the emerging economies. Under political pressure the state-owned banks managers tend to grant loans to projects with low yields or high risk. This in turns creates considerable amount of non-performing loans on the medium and long-term particularly during periods of economic turbulence. The consequences of this cycle are financial distress and bank failure. In the case of Turkey in 1994 crisis, the private banks were contesting to lend money to the government to exploit the high interest rates on governments bonds. When the government faced economic crisis, these banks were the fragile ones and were prepared to collapse. The Egyptian case is different. The state-owned banks are heavily involved in government lending and credit directing, however, these banks do not reveal the true status of its non-performing loans balance. These banks are privileged by receiving deposits from the majority of public sector entities.
Foreign and private banks, on the other hand, apply more prudent rules in credit granting. Unlike state-owned banks, these banks are not subject to political pressures. Consequently, they are not favoured by many companies to participate in financing projects, particularly high risk projects. The foreign banks followed by private banks focused on consumer finance to penetrate the market, asking customers to open accounts in later stages collaterals for the granted credit. The financial sectors in both countries require more liberal policies to be implemented. The privatisation of one or two of the large state-owned banks is important to stimulate further competition. The introduction of corporate governance and prudent rules to both banking sectors is essential to improve the intermediation activities in the banking sector. More transparency rules in financial reporting needed particularly in the state-owned banks accounts.

### 8.3. Limitations

The data limitations emerged in conducting the present thesis can be summarised as follows. More detailed data on banks non-performing loans and off-balance sheet items would help to assess the risk associated with banks operations. Also, the trends in banks operation in the sense of expanding in off-balance sheet activities. The number of employees and branches for each bank are not available in both data sets. The number of employees would be helpful as the labour input. The number of branches could be included as control variable to understand the effect of excessive branches on banks performance.
The time span for the Egyptian data stops at the year 2002 due to the unavailability of data on the selected banks in the sample. The time span of the Turkish banks data stops at the year 1999 due to the changes of accounting treatment by the Turkish Banking Association (TBB).

8.4. Future Research

The thesis counts for various sources of heterogeneity particularly in the parametric estimation of technical efficiency by incorporating bank specific variables in alternative stochastic frontier models with different underlying assumptions. Unlike the DEA methods, the SFA methods allow counting for heterogeneity. The fail to account for heterogeneity is likely to affect the stability of efficiency results [Bos et al. 2005; Al-Gamal and Inanoglu 2005; Mester 1997; and Berger and Mester, 1997]. I expect the effect of heterogeneity issue in banks efficiency and productivity studies will impose greater pressure on the linear programming methodology DEA. It is likely to see a trend in the future studies to employ SFA based parametric models particularly in measuring banks performance during period of economic or regulatory changes (Bos et al., 2005).

Banks studies also would question the approaches employed (i.e. production or intermediation approach) when applying particular methods or with certain economic circumstances (Tortos-Ausina 2002). For instance, Fortin and Leclerc (2007) questioned the usefulness of intermediation approach in assessing banks’
performance using DEA methods. They argue that in order to overcome biasness in measuring banks efficiency and productivity, a complete coverage of inputs and outputs is necessary. However, in this case the DEA under the intermediation approach will show banks as technically efficient. Consequently, the Malmquist decomposition of productivity growth becomes useless.

Measuring banks performance, efficiency or productivity in association with banks risk and corporate governance acquires significant attention from both researchers and policy makers eventually. Financial disruption represented in financial crisis or credit crunch stimulates the need to consider several types of risk. Unfortunately in some emerging economies the availability of detailed data on bank basis is scarce. Also, models that measures incorporate risk as ex-ante measure yet exists in the literature. Studies which consider all the above issues are strongly encouraged in bank performance studies.
Bibliography:


Arestis, P. (2000,) Financial Sector Reforms in Developing Countries with Special Reference to Egypt, Discussion paper South Bank University: London.


**APPENDICES:**

**Appendix 1: Table 1 Structure of the Egyptian Banking System (Part A)**

<table>
<thead>
<tr>
<th>Year</th>
<th>End Of June</th>
<th>Public Sector Banks</th>
<th>Private &amp; Joint Venture Banks</th>
<th>Business &amp; Investment Banks</th>
<th>Non-Commercial Banks</th>
<th>Specialized Banks</th>
<th>Principal Bank for Development &amp; Agricultural Credit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Banks</td>
<td>Branches</td>
<td>Banks</td>
<td>Branches</td>
<td>Banks</td>
<td>Branches</td>
<td>Banks</td>
<td>Branches</td>
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<td>51</td>
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<td>1988</td>
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<td>n.a</td>
<td>40</td>
<td>n.a</td>
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<td>n.a</td>
<td>22</td>
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<td>273</td>
<td>11</td>
<td>86</td>
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<tr>
<td>1997</td>
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<td>883</td>
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<td>298</td>
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<td>90</td>
<td>21</td>
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<td>1999</td>
<td>4</td>
<td>918</td>
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<td>383</td>
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<td>2005</td>
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<td>23</td>
<td>430</td>
<td>11</td>
<td>177</td>
<td>11</td>
<td>49</td>
</tr>
</tbody>
</table>

Source: Central Bank of Egypt
Appendix 1: Table 1 Structure of the Egyptian Banking System (Part B)

| * Egyptian banks abroad are not included, also two banks established under private laws and are not registered with the CBE (i.e. The Arab International Bank and Nasser Social Bank). |
| ** 13 banks of the development banks had been merged into the National bank for Development in Cairo in 1992 along with 2 banks in 1994. Also Bank of Credit and Commerce (Egypt) had been merged into Misr Bank in 1993. |
| *** One branch of the foreign banks operating in Egypt was crossed out in 1993 and other in 1998. |
| **** The Egyptian Real Estate Bank had been merged in the Arab Real Estate Bank in December 1999 according to the CBE decision in 21/6/1999. |
| ***** The decrease was because seven branches of foreign banks ended their business. |
| ***** The decline is ascribed to cases of bank mergers and acquisitions according to the CBE banking reform plan. |
### Appendix 1: Table 2: Egyptian Banks Aggregate Balance Sheet

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Cash</td>
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<td>3,220</td>
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<td>60,818</td>
<td>71,142</td>
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<td>19,187</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balances with banks in Egypt</td>
<td>30,658</td>
<td>28,991</td>
<td>29,274</td>
<td>30,710</td>
<td>35,549</td>
<td>37,703</td>
<td>42,608</td>
<td>44,607</td>
<td>45,098</td>
<td>49,400</td>
<td>67,047</td>
<td>83,245</td>
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</tr>
<tr>
<td>Balances with banks abroad</td>
<td>32,844</td>
<td>36,392</td>
<td>35,177</td>
<td>33,733</td>
<td>36,578</td>
<td>32,694</td>
<td>32,931</td>
<td>16,106</td>
<td>17,776</td>
<td>16,252</td>
<td>20,002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loans and discounts</td>
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<td>58,249</td>
<td>67,594</td>
<td>79,834</td>
<td>106,613</td>
<td>128,826</td>
<td>152,189</td>
<td>172,379</td>
<td>204,132</td>
<td>226,776</td>
<td>241,470</td>
<td>266,100</td>
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<td>Assets = Liabilities</td>
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<td>174,866</td>
<td>198,250</td>
<td>211,162</td>
<td>236,664</td>
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<td></td>
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<td></td>
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<tr>
<td>Capital</td>
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<td>5,627</td>
<td>5,909</td>
<td>7,096</td>
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<td>8,358</td>
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<td>7,132</td>
<td>8,132</td>
<td>9,226</td>
<td>10,156</td>
<td>11,238</td>
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<td>Long term loans &amp; Bonds</td>
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<td>24,210</td>
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<td>6,814</td>
<td>11,121</td>
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<td>9,970</td>
<td>11,486</td>
<td>11,831</td>
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<tr>
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<td>139,205</td>
<td>156,535</td>
<td>174,858</td>
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<td>33,977</td>
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Source: Central Bank of Egypt  
*The table includes Balance sheet items of Specialised banks and other banks not included in the Sample*
### Table 3: Egyptian Sample Banks Yearly Growth of Total Loans, Total Deposits and Total Assets By Ownership Category (1991-2002)

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<th>Year</th>
<th>Sample</th>
<th>Average</th>
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<td>2002</td>
<td>97,273.3</td>
<td>15.7</td>
</tr>
<tr>
<td>2001</td>
<td>95,403.6</td>
<td>6.9</td>
</tr>
<tr>
<td>2000</td>
<td>103,614.6</td>
<td>6.9</td>
</tr>
<tr>
<td>1999</td>
<td>95,403.6</td>
<td>9.2</td>
</tr>
<tr>
<td>1998</td>
<td>110,103.3</td>
<td>12.8</td>
</tr>
<tr>
<td>1997</td>
<td>107,036.3</td>
<td>10.1</td>
</tr>
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<td>1991</td>
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**Growth %**

- **Average**: 8.3

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample</th>
<th>Average</th>
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<tr>
<td>2002</td>
<td>97,273.3</td>
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<td>2001</td>
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<td>1993</td>
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<td>8.3</td>
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<td>1992</td>
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<td>12.6</td>
</tr>
<tr>
<td>1991</td>
<td>89,143.7</td>
<td>11.5</td>
</tr>
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</table>

**Growth %**

- **Average**: 8.3

### Foreign

<table>
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<th>Average</th>
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<td>15.7</td>
</tr>
<tr>
<td>2001</td>
<td>95,403.6</td>
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</tr>
<tr>
<td>2000</td>
<td>103,614.6</td>
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<tr>
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</tr>
<tr>
<td>1998</td>
<td>110,103.3</td>
<td>12.8</td>
</tr>
<tr>
<td>1997</td>
<td>107,036.3</td>
<td>10.1</td>
</tr>
<tr>
<td>1996</td>
<td>93,992.7</td>
<td>9.7</td>
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<tr>
<td>1995</td>
<td>89,143.7</td>
<td>9.4</td>
</tr>
<tr>
<td>1994</td>
<td>89,143.7</td>
<td>14.7</td>
</tr>
<tr>
<td>1993</td>
<td>89,143.7</td>
<td>8.3</td>
</tr>
<tr>
<td>1992</td>
<td>89,143.7</td>
<td>12.6</td>
</tr>
<tr>
<td>1991</td>
<td>89,143.7</td>
<td>11.5</td>
</tr>
</tbody>
</table>

**Growth %**

- **Average**: 8.3

### JVP

<table>
<thead>
<tr>
<th>Year</th>
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<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>97,273.3</td>
<td>15.7</td>
</tr>
<tr>
<td>2001</td>
<td>95,403.6</td>
<td>6.9</td>
</tr>
<tr>
<td>2000</td>
<td>103,614.6</td>
<td>6.9</td>
</tr>
<tr>
<td>1999</td>
<td>95,403.6</td>
<td>9.2</td>
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<tr>
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<td>12.6</td>
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<tr>
<td>1991</td>
<td>89,143.7</td>
<td>11.5</td>
</tr>
</tbody>
</table>

**Growth %**

- **Average**: 8.3

### By Ownership Category (1991-2002)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>97,273.3</td>
<td>15.7</td>
</tr>
<tr>
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</tr>
<tr>
<td>1991</td>
<td>89,143.7</td>
<td>11.5</td>
</tr>
</tbody>
</table>

**Growth %**

- **Average**: 8.3

### Population

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>97,273.3</td>
<td>15.7</td>
</tr>
<tr>
<td>2001</td>
<td>95,403.6</td>
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<td>103,614.6</td>
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<tr>
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</tr>
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<td>1998</td>
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<tr>
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<tr>
<td>1991</td>
<td>89,143.7</td>
<td>11.5</td>
</tr>
</tbody>
</table>

**Growth %**

- **Average**: 8.3

### Source: Central Bank of Egypt

Population includes Specialised banks and other banks not included in the Sample

---

**Note:** The table above presents yearly growth rates for total loans, total deposits, and total assets for Egyptian sample banks by ownership category from 1991 to 2002. The data is sourced from the Central Bank of Egypt.
Appendix 1: Table 4: Egyptian Sample Banks Market share of Total Loans, Total Deposits and Total Assets by Ownership Category (1991-2002)

<table>
<thead>
<tr>
<th>Table (4) Egyptian Sample Banks Market share of Total Loans, Total Deposits and Total Assets by Ownership Category (1991-2002)</th>
</tr>
</thead>
<tbody>
<tr>
<td>----------</td>
</tr>
<tr>
<td><strong>T. Loans</strong></td>
</tr>
<tr>
<td>Foreign</td>
</tr>
<tr>
<td>JVP</td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>State</td>
</tr>
<tr>
<td>Sample</td>
</tr>
<tr>
<td>Population</td>
</tr>
<tr>
<td><strong>T. Deposits</strong></td>
</tr>
<tr>
<td>Foreign</td>
</tr>
<tr>
<td>JVP</td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>State</td>
</tr>
<tr>
<td>Sample</td>
</tr>
<tr>
<td>Population</td>
</tr>
<tr>
<td><strong>T. Assets</strong></td>
</tr>
<tr>
<td>Foreign</td>
</tr>
<tr>
<td>JVP</td>
</tr>
<tr>
<td>Private</td>
</tr>
<tr>
<td>State</td>
</tr>
<tr>
<td>Sample</td>
</tr>
<tr>
<td>Population</td>
</tr>
</tbody>
</table>

Source: Central Bank of Egypt; Population includes Specialised banks and other banks not included in the Sample
Appendix 1: Table 5: Joint Venture (JV) Banks Privatisation offers in Egypt (1996-1999)

<table>
<thead>
<tr>
<th>Bank Name</th>
<th>Date</th>
<th>%</th>
<th>No. of Shares (000's)</th>
<th>No. of shares Listed in (000's)</th>
<th>Market Cap in $(000's)</th>
<th>T. Assets in $ (000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credite International d'Egypt (CIE)</td>
<td>1996</td>
<td>11.50%</td>
<td>82,445</td>
<td>717,000</td>
<td>76,109</td>
<td>920,558</td>
</tr>
<tr>
<td>Export Development Bank</td>
<td>1996</td>
<td>24.00%</td>
<td>600</td>
<td>2,500</td>
<td>300,147</td>
<td>2,500,475</td>
</tr>
<tr>
<td>Alexandria Comm. &amp; Mar. Bank</td>
<td>1997</td>
<td>27.00%</td>
<td>300</td>
<td>1,125</td>
<td>64,714</td>
<td>1,093,287</td>
</tr>
<tr>
<td>Bank du Caire et de Paris</td>
<td>1997</td>
<td>27.00%</td>
<td>7</td>
<td>26</td>
<td>68,451</td>
<td>1,173,412</td>
</tr>
<tr>
<td>Egyptian American Bank (EAB)</td>
<td>1997</td>
<td>20.00%</td>
<td>2,400</td>
<td>12,000</td>
<td>460,177</td>
<td>5,307,541</td>
</tr>
<tr>
<td>Misr Exterior Bank</td>
<td>1997</td>
<td>39.00%</td>
<td>2,847</td>
<td>7,300</td>
<td>324,012</td>
<td>5,422,964</td>
</tr>
<tr>
<td>Misr International Bank</td>
<td>1997</td>
<td>20.00%</td>
<td>4,500</td>
<td>22,500</td>
<td>667,965</td>
<td>8,979,760</td>
</tr>
<tr>
<td>National Societe General</td>
<td>1997</td>
<td>10.50%</td>
<td>1,050</td>
<td>10,000</td>
<td>133,038</td>
<td>3,079,483</td>
</tr>
<tr>
<td>Suez Canal Bank*</td>
<td>1997</td>
<td>34.00%</td>
<td>3,400</td>
<td>10,000</td>
<td>235,841</td>
<td>7,370,971</td>
</tr>
<tr>
<td>Commercial International Bank (CIB)</td>
<td>1998</td>
<td>25.00%</td>
<td>16,250</td>
<td>65,000</td>
<td>733,791</td>
<td>13,277,290</td>
</tr>
<tr>
<td>Misr Romania Bank</td>
<td>1998</td>
<td>18.00%</td>
<td>900</td>
<td>5,000</td>
<td>n.a</td>
<td>1,563,443</td>
</tr>
<tr>
<td>National Bank for Development</td>
<td>1998</td>
<td>26.00%</td>
<td>5,200</td>
<td>20,000</td>
<td>48,600</td>
<td>6,205,061</td>
</tr>
<tr>
<td>Cairo Barclays Bank</td>
<td>1999</td>
<td>11.00%</td>
<td>55</td>
<td>500</td>
<td>206,490</td>
<td>2,890,335</td>
</tr>
<tr>
<td>Egyptian Commercial Bank (ECB)</td>
<td>1999</td>
<td>10.00%</td>
<td>963</td>
<td>9,626</td>
<td>114,092</td>
<td>1,945,184</td>
</tr>
</tbody>
</table>

Source: Omran (2007)
Appendix 2: Table 1. Turkish Banking Sector: Selected Indicators for the Selected Years from 1980 to 2000.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Banks</td>
<td>43</td>
<td>66</td>
<td>67</td>
<td>81</td>
<td>79</td>
</tr>
<tr>
<td>Number of Branches</td>
<td>5,954</td>
<td>6,560</td>
<td>6,087</td>
<td>7,691</td>
<td>7,837</td>
</tr>
<tr>
<td>Number of on-line Branches</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>6,938</td>
<td>7,523</td>
</tr>
<tr>
<td>Number of ATMs</td>
<td>0</td>
<td>3,209</td>
<td>4,023</td>
<td>9,939</td>
<td>11,991</td>
</tr>
<tr>
<td>Number of POS</td>
<td>0</td>
<td>0</td>
<td>16,135</td>
<td>188,957</td>
<td>299,950</td>
</tr>
<tr>
<td>Personnel Employed</td>
<td>125,312</td>
<td>154,089</td>
<td>139,046</td>
<td>173,988</td>
<td>170,401</td>
</tr>
<tr>
<td>Credit Card Use (in thousands)</td>
<td>0</td>
<td>0</td>
<td>1,564</td>
<td>10,045</td>
<td>13,408</td>
</tr>
<tr>
<td>Bank Card Use (in thousands)</td>
<td>0</td>
<td>0</td>
<td>10,469</td>
<td>24,107</td>
<td>29,560</td>
</tr>
<tr>
<td>Credit Card Volume (USD$ Million)</td>
<td>0</td>
<td>0</td>
<td>1,273</td>
<td>12,410</td>
<td>16,413</td>
</tr>
</tbody>
</table>

Source: The Banks Association of Turkey and BRSA (2001)
Appendix 2: Table 2 Banking Sector: Financial Indicators for the Selected Years from 1980 to 2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets USD$ Million</td>
<td>20,785</td>
<td>58,171</td>
<td>52,552</td>
<td>133,533</td>
<td>155,237</td>
</tr>
<tr>
<td>Total Credits USD$ Million</td>
<td>11,168</td>
<td>27,342</td>
<td>20,559</td>
<td>40,206</td>
<td>50,931</td>
</tr>
<tr>
<td>Securities Portfolio USD$ Million</td>
<td>1,339</td>
<td>5,997</td>
<td>5,955</td>
<td>22,955</td>
<td>17,848</td>
</tr>
<tr>
<td>Total Deposits USD$ Million</td>
<td>10,188</td>
<td>32,564</td>
<td>33,191</td>
<td>89,361</td>
<td>101,884</td>
</tr>
<tr>
<td>Savings Deposits TL</td>
<td>4,288</td>
<td>19,343</td>
<td>24,190</td>
<td>58,807</td>
<td>64,352</td>
</tr>
<tr>
<td>Net worth /Profits USD$ Million</td>
<td>0</td>
<td>7,429</td>
<td>15,578</td>
<td>34,106</td>
<td>37,724</td>
</tr>
<tr>
<td>Non-deposit funding USD$ Million</td>
<td>1,289</td>
<td>11,760</td>
<td>9,019</td>
<td>22,934</td>
<td>29,435</td>
</tr>
<tr>
<td>Foreign banks USD$ Million</td>
<td>0</td>
<td>3,460</td>
<td>2,675</td>
<td>12,073</td>
<td>16,284</td>
</tr>
<tr>
<td>Total Assets/GNP (%)</td>
<td>28.6</td>
<td>38.2</td>
<td>40.3</td>
<td>71.7</td>
<td>76.9</td>
</tr>
<tr>
<td>Total Credits/GNP (%)</td>
<td>15.4</td>
<td>17.9</td>
<td>15.8</td>
<td>21.6</td>
<td>25.2</td>
</tr>
<tr>
<td>Securities Portfolio/GNP (%)</td>
<td>1.8</td>
<td>3.9</td>
<td>4.6</td>
<td>12.3</td>
<td>8.8</td>
</tr>
<tr>
<td>Savings Deposits/GNP (%)</td>
<td>5.9</td>
<td>12.7</td>
<td>18.5</td>
<td>31.6</td>
<td>31.9</td>
</tr>
<tr>
<td>State Bank Assets/ Total Sector Assets (%)</td>
<td>44.1</td>
<td>44.6</td>
<td>39.6</td>
<td>34.9</td>
<td>34.2</td>
</tr>
<tr>
<td>Off-balance Sheet Operations/ Total Assets (%)</td>
<td>0</td>
<td>0</td>
<td>49.5</td>
<td>103.5</td>
<td>100.8</td>
</tr>
</tbody>
</table>

Source: The Banks Association of Turkey and BRSA. (2001)

Appendix 2: Table 3 The Situation of the Banks Under SDIF from 1997 to January 25, 2002

<table>
<thead>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Banks Taken Over</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>8</td>
<td>---</td>
<td>19</td>
</tr>
<tr>
<td>Merged Banks</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Sold Banks</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Licence Withdraws</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>3</td>
<td>---</td>
<td>3</td>
</tr>
<tr>
<td>Under Legal Procedure</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>2</td>
<td>---</td>
<td>2</td>
</tr>
<tr>
<td>Banks Remaining under SDIF</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: BRSA (2002)
### Appendix 3: Table 1. Comparison between Egypt and Turkey

<table>
<thead>
<tr>
<th>Experience</th>
<th>Egypt</th>
<th>Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Repression</strong></td>
<td>• Before 1991: Credit directing, Barriers to entry, High State intervention, Controlled interest rate system, Highly segmented market (4 state-owned bank &gt; 0.65% market share “Deposits” and “Loans”), Negative real interest rate, Attempt to liberalisation “Infitah” (1975) foreign bank allowed (barriers to entry again in 1984)</td>
<td>• Before 1980: Credit directing, Barriers to entry, High State intervention, Controlled interest rate system, Highly segmented market (4 state-owned bank &gt; 50% market share “Deposits” and “Loans”), Negative real interest rate, Attempt to liberalisation 1960 promoting private sector intervention</td>
</tr>
<tr>
<td><strong>Liberalisation</strong></td>
<td>• In 1991: ERSAP (IMF, WB), Lifting interest rate ceiling, Minimization of government intervention in credit allocation, Gradualism Cautiousness and slow momentum of implementation, Privatising the public sector share in the 23 joint venture (JV) banks (late 1995)</td>
<td>• In 1980: SAP (IMF, WB and OECD), Lifting interest rate ceiling, abolishing restrictions on lending interest rate, Allowing both resident and non-resident to open foreign deposits accounts, Free entrance for foreign banks, Lack of gradualism and high speed of implementation</td>
</tr>
<tr>
<td><strong>Crisis</strong></td>
<td>No Crisis</td>
<td>• Banks Crisis in 1982, interest rate soaring, the collapse of six banks, Bank crisis in 1994 soaring inflation 70%, TL devaluation (60%) and overnight interest rate uttermost to 1000%, “Moral Hazard”, November 2000 Crisis, Currency crisis February 2001</td>
</tr>
<tr>
<td><strong>Bank Performance</strong></td>
<td>No studies (The present study efficiency improvement)</td>
<td>• Efficiency gains after liberalisation policies in early 1980s, No significant improvement in efficiency in late 1990’s (Gunay and Tektas, 2006), (Yildirim, 2002), (Isik and Hassan, 2002) and (Zaim, 1995)</td>
</tr>
</tbody>
</table>
Appendix 4: The Malmquist Productivity index Decomposition

Dilemma

The scale efficiency change component in equation (4.9) in chapter 4 is the geometric mean of two scale efficiency change measures. However, the first is measured to period t technology and the second is measured to period t+1 technology. The added subscripts V and C relate to VRS and CRS technologies, respectively. The distance functions (TC) in equation (4.8) in chapter 4 are calculated relative to CRS technology unlike the distance functions (PTEC) in equation (4.7) in chapter 4, which are calculated relative to VRS technology. This makes the above-suggested decomposition a controversial proposition. The FGNZ (1994) eventually is being subject to extensive debates in the literature. The main criticism is that, if there is scale efficiency change then, consequently the true production technology must be VRS. However, the proposed decomposition introduces a technical change measure that reflects the movement on a CRS frontier and not a VRS frontier.

Grifell-Tatje and Lovell (1995) highlighted this problem in the FGNZ (1994) decomposition. According to them, the Malmquist productivity index does not provide an accurate measure of productivity change in the presence of non-constant return to scale. They argue that the bias is systematic and exaggerates the productivity change when inputs growth exists under the variable return to scale, and understates the productivity change when inputs growth exist under increasing returns to scale. Indeed the direction of biases is reversed in case of input contraction. Grifell-Tatje and Lovell (1995) elaborate that the linear programming techniques used to calculate the Malmquist index tends to force the index to exaggerate the biases inherent in the theoretical Malmquist index.

Ray and Desli (1997) report that the FGNZ decomposition is misleading for the same reasons and introduces an alternative decomposition of the Malmquist index. In their decomposition, pure technical change is similar to the one in FGNZ. However; both the technological change and scale efficiency changes are different. Unlike, FGNZ Ray and Desli measure the TC in the VRS reference technology, and the scale efficiency term as the geometric mean of the scale efficiency ratio using the technology at t and t+1 as reference instead.
Grifell-Tatje and Lovell (1998) used artificial data to prove that the FGNZ version of Malmquist index does not provide accurate decomposition of the productivity change even in a restrictive $M=N=1^{186}$ environment. This suggests that it is even unlikely to succeed in more realistic$^{187}$ environments. Grifell-Tatje and Lovell (1998) introduce the Generalized Malmquist index (GMI), which, unlike FGNZ provides accurate decomposition of productivity growth in the $M=N=1$ case. Nevertheless the authors clarify that they could not reach a precise conclusion about whether their proposed GMI and the Ray and Desli index would provide an accurate decomposition in more realistic case ($M>1$ and or $N>1$).

According to Balk (2001), the FGNZ (1994) scale efficiency term can be decomposed to scale efficiency change, output-mix effect and technical change which he has considered as double-counting of the technical change component in calculating the overall Malmquist productivity index. Balk (2001), also criticized Ray and Desli (1997) decomposition by demonstrating that it is still combining the scale efficiency change with the output effect mix. Balk extended his criticism to the two proposed decomposition of Malmquist productivity index by Wheelock and Wilson (1999)$^{188}$, and Zofio and Lovell (1999)$^{189}$ by claiming that their decomposition is confusing rather than illuminating. In contrast, he found the proposed decomposition of Grifell-Tatje and Lovell (1998) rather appealing if and only if “$M=N=1$” and that they managed to disregard the output-mix effect.

Balk (2001) proposes three classes of new measures of productivity change, encompassing technological change, technical efficiency change, scale efficiency change, and input or output-mix change (dependent on the orientation chosen). He applied two of these measures on Dutch firms panel data and compare it with Malmquist productivity index (which captures only efficiency change and technical change) The author found a huge variation between the outcome of his proposed measure and Malmquist index measure due to the fluctuation of the input-mix term and

\[186 \text{ } M=N=1 \text{ refers to a single input single output technology.} \]
\[187 \text{ } \text{Multiple input output technology.}\]
\[188 \text{ } \text{Wheelock and Wilson (1999) interpreted the second factor in their scale efficiency term as measuring the shape of the technology.}\]
\[189 \text{ } \text{Zofio and Lovell (1999) interpreted the second factor in their scale efficiency term as measuring the scale bias of technical change.}\]
conclude that, ignoring the scale efficiency and the input–mix at least in his cast would lead to a glorious picture of productivity change.

Grosskopf (2003) and Lovell (2003) introduce comprehensive surveys on this issue. The two papers investigated, compared, and contrasted the different proposition introduced by different authors to decompose the Malmquist productivity index. Lovell (2003) differentiates between Malmquist productivity index and Malmquist Total Factor Productivity Index. With regard to Malmquist productivity index he concludes that Ray and Desli (1997) is preferable to the FGNZ (1994) decomposition Lovell (2003) claims that the later is inadequate measure for productivity change. Furthermore, he provided two alternative extended decompositions.\(^{190}\)

With regard to the total factor productivity change Lovell (2003) concludes that Balk (1998) was pessimistic in his claim that this index cannot be decomposed. Also, he obtained two economically meaningful decompositions utilising similar structure to the extended decomposition of Malmquist index. Grosskopf (2003) confirms that the Malmquist index that was originally proposed by CCD is defined relative to an unobservable true technology. This might or might not satisfy CRS. The alternative proposed decompositions of Malmquist index have been motivated by the presumption that the “true” technology is VRS technology in DEA world. In this case some adjustments must be made to produce an overall productivity index consistent with the average product notion required by CRS. Grosskopf (2003) concludes that these adjustments are the main source of the decomposition dispute. The author elaborates that, there was nothing “wrong” with estimating the Malmquist index based on empirical VRS technology however, researchers must clarify in their analysis that this approach does not have an average product interpretation.

Grosskopf demonstrate that the extended decomposition of Ray and Desli (1997) is related to FGNZ (1994) and is consistent with the proposition made by Simar and Wilson (1998), and employed by Wheelock and Wilson (1999), Gilbert and Wilson (1998), and Grifell-Tatje and Lovell (1998). Grosskopf (2003) find that Balk (2001) introduced more elaborated decomposition by encompassing input and output-mix terms to the index. Despite the controversial disputes regarding the decomposition of the index still considerable amount of research [Among others Isik and Hassan (2002)]

\(^{190}\) Lovell (2003) introduced an approach of Malmquist Productivity decomposition - one decomposing the activity effect and the other decomposing the technical change.
Appendix 5: The Origin and Development of the Stochastic Frontier Analysis (SFA):

Stochastic Frontier Analysis (SFA) is an alternative econometric method for frontier measurement. Unlike non-parametric linear programming techniques SFA, assumes a given functional form for the relationship between inputs and outputs. The theoretical debate introduced by Koopmans (1951)\textsuperscript{191}, Debreu (1951) and Shephard (1953)\textsuperscript{192}, on the productive efficiency literature had direct influence on the development of SFA (Kumbhakar and Lovell, 2000). The deterministic production frontier is given as:

\[ y_i = f(\chi_i; \beta) \times \exp\{-u_i\} \quad (1) \]

where as \( TE_i = \exp\{-u_i\} \) and \( u_i \geq 0 \)

Transformed to log-linear, the deterministic production frontier model becomes

\[ \ln y_i = \ln f(\chi_i; \beta) - u_i \quad (2) \]

Or

\[ \ln y_i = \beta_0 + \sum \beta_n \ln x_{ni} - u_i \quad (3) \]

where \( u_i \geq 0 \) guarantees that \( y_i \leq f(\chi_i; \beta) \)

Aigner and Chu (1968) demonstrate that the deterministic production frontier can be converted into two mathematical programming models employing “The Goal Programming Approach”. The first is a linear programming model and the second is a quadratic programming model. The major drawback of the goal programming approach is that the parameters are calculated using mathematical programming techniques rather than regression techniques.

\textsuperscript{191} Koopmans defined the technical efficiency: A producer is technically efficient if, and only if, it is impossible to produce more of any output without producing less of some other output or using more of some inputs.

\textsuperscript{192} Debreu and Shephard introduced distance functions as a way of modelling multiple-output technology.
Schmidt (1976) finds that by imposing a distributional assumption on $u_i$ the linear programming method can have a statistical interpretation. Hence, the Aigner and Chu (1968) optimisation criteria could work better with the use of log-likelihood functions. However, Schmidt also perceives that the statistical properties of the maximum likelihood estimators cannot be obtained by traditional methods. Green (1980) show that using the Hessians of the log likelihood functions will overcome this problem. He also introduced an alternative method in which $\mu_i \geq 0$ follows a gamma distribution.

Winsten (1957) suggests the Corrected Ordinary Least Squares (COLS) method in his discussion of Farrell’s original work. The main drawback of COLS frontier is that it does not necessarily bound the data from the above as closely as possible (Kumbhakar and Lovell, 2000). Afriat (1972) and Richmond (1974), introduce the Modified Ordinary Least Squares (MOLS) by estimating the deterministic production frontier using OLS method under the assumption that the disturbances follow explicit one-sided distribution, such as exponential or half normal for more details see Fare et al (1994), Coelli et al (2005), Greene (1997), and Kumbhakar and Lovell (2000) for more theoretical and empirical problems.

**Stochastic Frontier Analysis (SFA): The Method**

The previous discussions show that the main problem with the deterministic methods is that they do not allow for the disentanglement of the stochastic shock from inefficiency in the residual. The stochastic production frontier model (the composed error model) is given as:

$$\ln y_i = \beta_0 + \sum_n \beta_n \ln x_{ni} + v_i - u_i$$  \hspace{1cm} (4)

where: $\mu_i \geq 0$

$f(\chi; \beta)$: Production function

$\mu_i$: Non-negative technical inefficiency component

$v_i$: Two-sided noise component

$\beta$: Elasticity of inputs
\( \mathbf{x}_i \): Input variables for \( i \) number of banks

\( \mathbf{y}_i \): Output variables \( i \) number of banks

The noise component \( \mathbf{v}_i \) is assumed to be independently and identically distributed (iid) and symmetrically distributed independent of \( \mathbf{\mu}_i \) (the inefficiency). Thus, the error term \( \mathbf{e}_i = \mathbf{v}_i - \mathbf{u}_i \) is asymmetric, since \( \mathbf{\mu}_i \geq 0 \) assuming that \( \mathbf{v}_i \) and \( \mathbf{\mu}_i \) are distributed independently of \( \mathbf{x}_i \), then the estimation of (4.19) by OLS provides consistent estimates of \( \beta \) but not of \( \beta_0 \). Since \( \mathbb{E}(\mathbf{e}_i) = -\mathbb{E}(\mathbf{\mu}_i) \leq 0 \). The main drawback of OLS is that it does not provide estimates of producer specific technical efficiency.

Aigner, Lovell and Schmidt (ALS) (1977) obtained Maximum Likelihood (ML) under the assumptions;

\[
\mathbf{v}_i \sim iid \; N(0, \sigma_v^2) \tag{5}
\]

\[
\mathbf{\mu}_i \sim iid \; N(0, \sigma_\mu^2) \tag{6}
\]

Assumption 4.20 explains that \( \mathbf{v}_i \) is independently and identically distributed (iid) normal random variables with zero means and variance \( \sigma_v^2 \). Assumption 4.21 explains that \( \mathbf{\mu}_i \) is independently and identically distributed half-normal random variable with scale parameter \( \sigma_\mu^2 \). The probability density function of each \( \mathbf{\mu}_i \) is a truncated version of a normal random variable having zero mean and variance \( \sigma_\mu^2 \).

Forsund, Lovell and Schmidt (1980) find that it is not possible to estimate technical efficiency by observation. In contrast Jondrow, Lovell, Materov and Schmidt (JLMS) (1982) manage to provide estimates for each producer in the sample the verdict that enormously enhanced the appeal of SFA. Since JLMS paper several distributional assumptions has been suggested for the two components of the error term\(^{193} \)

\[
\mathbf{\mu}_i \sim iid \; G(\lambda,0) \{\text{Exponential with mean } \lambda\} \tag{7}
\]

\[
\mathbf{\mu}_i \sim iid \; N(\mu, \sigma_\mu^2) \{\text{Truncated normal}\} \tag{8}
\]

\( \mu_i \sim iid \; G(\lambda, m) \) \{Gamma with mean \( \lambda \) and degrees of freedom \( m \} \) (9)

The exponential frontier model suggested by both ALS and MB is in (7). The truncated normal frontier model introduced by Stevenson (1980) is in (8), while the gamma model is due to Greene (1990) is in (9) (see Kumbhakar and Lovell (2000) for the log-likelihood functions of these different models). Since Aigner et al (1977), Mueesen and Broeck (1977), and Battese and Corra (1977) employed Maximum Likelihood (ML) in stochastic frontier analysis and the proposition of decomposing \( \epsilon = v_i - u_i \) suggested by JLMS (1982) there have been many distributional assumptions of the inefficiency \( \mu_i \) term.

However, it is still controversial in the literature which distributional assumption is deemed the most accurate in estimating and ranking of the efficiency scores. Some empirical studies found that both ranking and the efficiency scores are very similar when compared under different distributional assumptions. For more details, see Greene (1993) and Kumbhakar and Lovell (2000).

In contrast Coelli et al (2005), elaborate that the choice among one of these distributional assumption could be influenced by theoretical considerations to the research at hand. The authors argue that the half-normal and exponential distributions are avoidable by some researchers. Both distributions have a mode at zero, which implies that most of the inefficiency points are in the neighbourhood of zero and consequently the technical efficiency measures are in the neighbourhood of one. Unlike the half-normal and exponential distributions the truncated normal and the gamma models are flexible and allow for wider range of distributional shape but have computational complexities.
Appendix 6: STATA 9.1. Code for the Egyptian banks Data

Generalised Malmquist Total Factor Productivity Index and its components:

1. `gen double tp = bt + (blny1t * lny1) + (blny2t * lny2) + (blny3t * lny3) + (blnx1t * lnX1) + (blnx3t * lnX3) + (btt * t)`
2. `gen double ey1 = blny1 + blny11 * lny1 + blny12 * lny2 + blny13 * lny3 + blny1X1 * lnX1 + blny1X3 * lnX3 + blny1t * t`
3. `gen double ey2 = blny2 + blny22 * lny2 + blny1y2 * lny1 + blny2y3 * lny3 + blny2X1 * lnX1 + blny2X3 * lnX3 + blny2t * t`
4. `gen double ey3 = blny3 + blny33 * lny3 + blny1y3 * lny1 + blny2y3 * lny2 + blny3X1 * lnX1 + blny3X3 * lnX3 + blny3t * t`
5. `gen double ex1 = blnx1 + blnx11 * lnX1 + blny1X1 * lny1 + blny2X1 * lny2 + blny3X1 * lny3 + blnx1X3 * lnX3 + blnx1t * t`
6. `gen double ex3 = blnx3 + blnx33 * lnX3 + blny1X3 * lny1 + blny2X3 * lny2 + blny3X3 * lny3 + blnx1X3 * lnX1 + blnx3t * t`
7. `gen double RTS = -1 / (ey1 + ey2 + ey3)`
8. `gen SF = (1 / RTS - 1)`
9. `gen double wey1 = ey1 / (ey1 + ey2 + ey3)`
10. `gen double wey2 = ey2 / (ey1 + ey2 + ey3)`
11. `gen double wey3 = ey3 / (ey1 + ey2 + ey3)`

* time are in ( year )

12. `bysort id (year): gen tem4_1=tem4[_n-1]`
13. `bysort id (year): gen tp_1=tp[_n-1]`
14. `gen TC = ((tp + tp_1)/2)`
15. `bysort id (year): gen wey1_1=wey1[_n-1]`
16. `bysort id (year): gen wey2_1=wey2[_n-1]`
17. `bysort id (year): gen wey3_1=wey3[_n-1]`
18. `bysort id (year): gen SF_1=SF[_n-1]`
19. `bysort id (year): gen lny1_1=lny1[_n-1]`
20. `bysort id (year): gen lny2_1=lny2[_n-1]`
21. `bysort id (year): gen lny3_1=lny3[_n-1]`
22. `gen SEC = (((wey1_1*SF_1) + (wey1* SF)) + ((wey2_1*SF_1) + (wey2* SF)) + ((wey3_1*SF_1) + (wey3* SF))) / 3`
23. `gen TECM4 = ln(tem4_1/tem4)`
24. `gen TFPC = TECM4 + TC + SEC`
25. `gen TEIM4 = exp(TECM4)`
26. `gen TCIM4 = exp(TC)`
27. `gen SECIM4 = exp(SEC)`
28. `gen GTPFIM4 = TEIM4*TCIM4*SECIM4`
29. `sum TECM4 TC SEC TFPC`
30. `sum TEIM4 TCIM4 SECIM4 GTPFIM4`
Appendix 7: STATA 9.1. Code for the Turkish banks data

Generalised Malmquist Total Factor Productivity Index and its components

1. `gen double tp = bt + (bny1t * lny1) + (bny2t * lny2) + (bny3t * lny3) + (blnX1t * lnX1) + (bt * t)`
2. `gen double ey1 = blny1 + blny11* lny1 + blny12* lny2 + blny13* lny3 + blny1X1 * lnX1 + blny1t * t`
3. `gen double ey2 = blny2 + blny22 * lny2 + blny1y2 * lny1 + blny2y3 * lny3 + blny2X1 * lnX1 + blny2t * t`
4. `gen double ey3 = blny3 + blny33 * lny3 + blny1y3 * lny1 + blny2y3 * lny2 + blny3X1 * lnX1 + blny3t * t`
5. `gen double eX1 = blnX1 + blnX11 * lnX1 + blny1X1 * lny1 + blny2X1 * lny2 + blnX1t * t`
6. `gen eys1= ey1 if ey1<0`
7. `gen eys2 = ey2 if ey2<0`
8. `gen eys3 = ey3 if ey3<0`
9. `gen double RTS = -1 / (ey1 + ey2 + ey3)`
10. `gen SF = ((1/RTS)-1)`
11. `gen double weys1 = eys1/(eys1 + eys2 + eys3)`
12. `gen double weys2 = eys2/(eys1 + eys2 + eys3)`
13. `gen double weys3 = eys2/(eys1 + eys2 + eys3)`

• time are in [ year ]

14. `bysort id (year): gen tem4a_1=tem4a[_n-1]`
15. `bysort id (year): gen tp_1=tp[_n-1]`
16. `gen TC = ((tp + tp_1)/2)`
17. `bysort id (year): gen wey1_1= wey1[_n-1]`
18. `bysort id (year): gen wey2_1= wey2[_n-1]`
19. `bysort id (year): gen wey3_1= wey3[_n-1]`
20. `bysort id (year): gen SF_1= SF[_n-1]`
21. `gen SEC = (((wey1_1*SF_1) + (wey1* SF))+ ((wey2_1*SF_1) + (wey2* SF))+ ((wey3_1*SF_1) + (wey3* SF)))*0.5`
22. `gen TECM4a = ln(tem4a/tem4a_1)`
23. `gen TFPC = TECM4a + TC + SEC`
24. `gen TEIM4a = exp(TECM4a)`
25. `gen TCIM4a= exp(TC)`
26. `gen SECIM4a = exp(SEC)`
27. `gen GTPFIM4a = TEIM4a*TCIM4a*SECIM4a`
28. `sum TECM4a TC SEC TFPC`
29. `sum TEIM4a TCIM4a SECIM4a GTPFIM4a`
Appendix 8: Table 1 Non-parametric Yearly Average Technical efficiency scores and Returns to Scale Egyptian banks

<table>
<thead>
<tr>
<th>Year</th>
<th>CRS TE</th>
<th>VRS TE</th>
<th>Scale</th>
<th>CRS</th>
<th>DRS</th>
<th>IRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>0.73</td>
<td>0.76</td>
<td>0.95</td>
<td>12</td>
<td>48%</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>1985</td>
<td>0.74</td>
<td>0.78</td>
<td>0.93</td>
<td>9</td>
<td>36%</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>1986</td>
<td>0.76</td>
<td>0.82</td>
<td>0.91</td>
<td>10</td>
<td>40%</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>1987</td>
<td>0.73</td>
<td>0.78</td>
<td>0.93</td>
<td>8</td>
<td>32%</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>1988</td>
<td>0.71</td>
<td>0.78</td>
<td>0.90</td>
<td>8</td>
<td>32%</td>
<td>4</td>
<td>12%</td>
</tr>
<tr>
<td>1989</td>
<td>0.73</td>
<td>0.80</td>
<td>0.89</td>
<td>7</td>
<td>28%</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>1990</td>
<td>0.75</td>
<td>0.80</td>
<td>0.93</td>
<td>7</td>
<td>28%</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>1991</td>
<td>0.76</td>
<td>0.81</td>
<td>0.94</td>
<td>5</td>
<td>20%</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td>1992</td>
<td>0.88</td>
<td>0.94</td>
<td>0.93</td>
<td>11</td>
<td>44%</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td>1993</td>
<td>0.92</td>
<td>0.98</td>
<td>0.94</td>
<td>11</td>
<td>44%</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>1994</td>
<td>0.89</td>
<td>0.97</td>
<td>0.92</td>
<td>12</td>
<td>48%</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td>1995</td>
<td>0.83</td>
<td>0.87</td>
<td>0.95</td>
<td>13</td>
<td>52%</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td>1996</td>
<td>0.54</td>
<td>0.69</td>
<td>0.80</td>
<td>5</td>
<td>20%</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>1997</td>
<td>0.82</td>
<td>0.89</td>
<td>0.91</td>
<td>9</td>
<td>36%</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>1998</td>
<td>0.88</td>
<td>0.91</td>
<td>0.96</td>
<td>9</td>
<td>36%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>1999</td>
<td>0.91</td>
<td>0.94</td>
<td>0.96</td>
<td>10</td>
<td>40%</td>
<td>10</td>
<td>40%</td>
</tr>
<tr>
<td>2000</td>
<td>0.92</td>
<td>0.96</td>
<td>0.96</td>
<td>10</td>
<td>40%</td>
<td>7</td>
<td>28%</td>
</tr>
<tr>
<td>2001</td>
<td>0.90</td>
<td>0.96</td>
<td>0.94</td>
<td>11</td>
<td>44%</td>
<td>7</td>
<td>28%</td>
</tr>
<tr>
<td>2002</td>
<td>0.90</td>
<td>0.97</td>
<td>0.94</td>
<td>8</td>
<td>32%</td>
<td>8</td>
<td>32%</td>
</tr>
<tr>
<td>Average</td>
<td>0.80</td>
<td>0.86</td>
<td>0.93</td>
<td>9</td>
<td>37%</td>
<td>11</td>
<td>45%</td>
</tr>
</tbody>
</table>
Appendix 8: Table 2 Egyptian Banks Non-parametric Average efficiency scores and Ranks (by Bank)

<table>
<thead>
<tr>
<th>Bank</th>
<th>CRS</th>
<th>Rank</th>
<th>VRS</th>
<th>Rank</th>
<th>Sale eff.</th>
<th>Rank</th>
<th>Ownership</th>
<th>Size</th>
<th>No. of Year / % of total</th>
<th>No. of years</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>0.87</td>
<td>9</td>
<td>0.91</td>
<td>9</td>
<td>0.97</td>
<td>4</td>
<td>JV_TF</td>
<td>S</td>
<td>8</td>
<td>42% 9 47% 2 11% 19</td>
</tr>
<tr>
<td>AFIB</td>
<td>0.83</td>
<td>11</td>
<td>0.89</td>
<td>10</td>
<td>1.00</td>
<td>1</td>
<td>JV_TF</td>
<td>L</td>
<td>8</td>
<td>42% 6 32% 5 26% 19</td>
</tr>
<tr>
<td>AIBC</td>
<td>0.58</td>
<td>24</td>
<td>0.67</td>
<td>25</td>
<td>0.95</td>
<td>7</td>
<td>JV_TF</td>
<td>S</td>
<td>3</td>
<td>16% 2 11% 14 74% 19</td>
</tr>
<tr>
<td>AMCB</td>
<td>0.79</td>
<td>14</td>
<td>0.84</td>
<td>14</td>
<td>0.96</td>
<td>5</td>
<td>JV_TF</td>
<td>S</td>
<td>4</td>
<td>21% 4 21% 11 58% 19</td>
</tr>
<tr>
<td>AUB</td>
<td>0.79</td>
<td>15</td>
<td>0.82</td>
<td>16</td>
<td>0.87</td>
<td>23</td>
<td>P_TF</td>
<td>S</td>
<td>9</td>
<td>47% 9 47% 1 5% 19</td>
</tr>
<tr>
<td>B Misr</td>
<td>0.92</td>
<td>6</td>
<td>0.98</td>
<td>6</td>
<td>0.93</td>
<td>16</td>
<td>State</td>
<td>L</td>
<td>9</td>
<td>47% 10 53% 0 0% 19</td>
</tr>
<tr>
<td>Barcalys</td>
<td>0.74</td>
<td>19</td>
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## Appendix 8: Table 2 Egyptian Banks Yearly Non-parametric Average VRS efficiency scores (by ownership)

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Appendix 8: Table 3 Egyptian Banks Yearly Non-parametric Malmquist Total Factor Productivity Index (MTFPI) and its components.

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<td>0.994</td>
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Appendix 9: Table 1 Egyptian Banks Yearly Parametric Average Efficiency (by Ownership)

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<td>0.618</td>
<td>0.4</td>
<td>0.637</td>
<td>0.765</td>
<td>0.666</td>
</tr>
<tr>
<td>2002</td>
<td>0.69</td>
<td>0.73</td>
<td>0.696</td>
<td>0.636</td>
<td>0.42</td>
<td>0.657</td>
<td>0.775</td>
<td>0.682</td>
</tr>
<tr>
<td>Total</td>
<td>0.513</td>
<td>0.561</td>
<td>0.53</td>
<td>0.448</td>
<td>0.225</td>
<td>0.467</td>
<td>0.629</td>
<td>0.51</td>
</tr>
</tbody>
</table>
Appendix 9: Table 2 Egyptian Banks Yearly Parametric Generalised Malmquist Total Factor Productivity Index (GMTFPI) and its components.

<table>
<thead>
<tr>
<th>Year</th>
<th>TECI</th>
<th>TCI</th>
<th>SECI</th>
<th>GMTFPI</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>1.08</td>
<td>0.98</td>
<td>1.30</td>
<td>1.38</td>
<td>32%</td>
</tr>
<tr>
<td>1986</td>
<td>1.08</td>
<td>0.98</td>
<td>1.32</td>
<td>1.39</td>
<td>33%</td>
</tr>
<tr>
<td>1987</td>
<td>1.07</td>
<td>0.98</td>
<td>1.33</td>
<td>1.39</td>
<td>33%</td>
</tr>
<tr>
<td>1988</td>
<td>1.07</td>
<td>0.98</td>
<td>1.33</td>
<td>1.39</td>
<td>33%</td>
</tr>
<tr>
<td>1989</td>
<td>1.06</td>
<td>0.97</td>
<td>1.34</td>
<td>1.38</td>
<td>32%</td>
</tr>
<tr>
<td>1990</td>
<td>1.05</td>
<td>0.97</td>
<td>1.33</td>
<td>1.36</td>
<td>30%</td>
</tr>
<tr>
<td>1991</td>
<td>1.06</td>
<td>0.96</td>
<td>1.31</td>
<td>1.34</td>
<td>29%</td>
</tr>
<tr>
<td>1992</td>
<td>1.05</td>
<td>0.96</td>
<td>1.29</td>
<td>1.31</td>
<td>27%</td>
</tr>
<tr>
<td>1993</td>
<td>1.05</td>
<td>0.96</td>
<td>1.30</td>
<td>1.31</td>
<td>27%</td>
</tr>
<tr>
<td>1994</td>
<td>1.05</td>
<td>0.96</td>
<td>1.31</td>
<td>1.31</td>
<td>27%</td>
</tr>
<tr>
<td>1995</td>
<td>1.04</td>
<td>0.96</td>
<td>1.33</td>
<td>1.33</td>
<td>28%</td>
</tr>
<tr>
<td>1996</td>
<td>1.04</td>
<td>0.95</td>
<td>1.35</td>
<td>1.34</td>
<td>29%</td>
</tr>
<tr>
<td>1997</td>
<td>1.04</td>
<td>0.95</td>
<td>1.35</td>
<td>1.33</td>
<td>29%</td>
</tr>
<tr>
<td>1998</td>
<td>1.03</td>
<td>0.95</td>
<td>1.36</td>
<td>1.33</td>
<td>28%</td>
</tr>
<tr>
<td>1999</td>
<td>1.03</td>
<td>0.94</td>
<td>1.37</td>
<td>1.34</td>
<td>29%</td>
</tr>
<tr>
<td>2000</td>
<td>1.03</td>
<td>0.94</td>
<td>1.39</td>
<td>1.35</td>
<td>30%</td>
</tr>
<tr>
<td>2001</td>
<td>1.03</td>
<td>0.94</td>
<td>1.40</td>
<td>1.35</td>
<td>30%</td>
</tr>
<tr>
<td>2002</td>
<td>1.03</td>
<td>0.93</td>
<td>1.41</td>
<td>1.35</td>
<td>30%</td>
</tr>
<tr>
<td>All</td>
<td>1.05</td>
<td>0.96</td>
<td>1.34</td>
<td>1.35</td>
<td>30%</td>
</tr>
</tbody>
</table>
Appendix 10: Table 1 Turkish Market Analysis
Ownership

1991

1992

1993

1994

1995

1996

1997

1998

1999

2000

Average

287

249

243

176

265

327

561

622

576

799

410.5

%of Sample

1.7%

1.3%

1.2%

1.2%

1.2%

1.2%

1.7%

1.9%

2.3%

2.5%

1.6%

%of industry
fixed Assets

1.1%

0.9%

0.8%

0.9%

0.9%

0.9%

1.3%

1.4%

1.4%

1.6%

1.1%

17

11

49

40

54

73

80

111

113

136

68.4

%of Sample

0.74%

0.39%

1.54%

1.53%

1.54%

1.93%

2.31%

2.77%

3.27%

3.35%

1.9%

%of industry

0.60%

0.35%

1.39%

1.36%

1.40%

1.77%

2.07%

2.42%

2.79%

2.79%

1.7%

Deposits
%of Sample

350

309

282

266

438

731

1055

1207

1272

1882

779.2

1.31%

0.97%

0.90%

0.90%

1.12%

1.45%

2.00%

1.81%

1.66%

2.17%

1.4%

%of industry

1.07%

0.87%

0.75%

0.80%

0.98%

1.28%

1.72%

1.57%

1.42%

1.85%

1.2%

Intermediation

82.0%

80.6%

86.2%

66.2%

60.5%

44.7%

53.2%

51.5%

45.3%

42.5%

61.3%

Foreign

Loans

SDIF

Private

Loans

6334

6970

8327

5473

7868

10731

12776

14482

12595

17022

10257.8

%of Sample
%of industry

38.0%

36.4%

40.8%

36.8%

35.9%

40.1%

39.7%

44.6%

51.4%

53.7%

41.7%

24.7%

25.8%

27.8%

26.6%

26.8%

29.9%

29.7%

32.2%

31.3%

33.4%

28.8%

fixed Assets

630

667

628

502

707

737

845

1103

1187

1606

861.2

%of Sample

27.36%

23.59%

19.77%

19.21%

20.22%

19.46%

24.39%

27.55%

34.36%

39.54%

25.5%

%of industry
Deposits

22.19%

21.15%

17.81%

17.07%

18.32%

17.90%

21.89%

24.09%

29.31%

32.91%

22.3%

10209

10764

11124

10767

13487

16414

17207

21274

23955

27561

16276.2

%of Sample

38.13%

33.68%

35.38%

36.48%

34.36%

32.64%

32.62%

31.96%

31.20%

31.76%

33.8%

%of industry

31.14%

30.15%

29.51%

32.41%

30.11%

28.71%

28.08%

27.59%

26.81%

27.05%

29.2%

Intermediation

62.0%

64.8%

74.9%

50.8%

58.3%

65.4%

74.2%

68.1%

52.6%

61.8%

63.3%

2384

3255

4258

3149

4175

5064

5999

6705

5826

7256

4807.1

Loans
%of Sample

14.3%

17.0%

20.9%

21.2%

19.1%

18.9%

18.6%

20.7%

23.8%

22.9%

19.7%

%of industry

9.3%

12.0%

14.2%

15.3%

14.2%

14.1%

13.9%

14.9%

14.5%

14.3%

13.7%

fixed Assets

165

380

382

312

496

556

506

707

716

927

514.7

%of Sample
%of industry

7.16%

13.44%

12.02%

11.94%

14.19%

14.68%

14.61%

17.66%

20.72%

22.82%

14.9%

5.81%

12.05%

10.83%

10.61%

12.86%

13.50%

13.11%

15.44%

17.68%

19.00%

13.1%

2764

5031

4349

4628

6565

8031

10113

12726

15989

16248

8644.4

%of Sample

10.32%

15.74%

13.83%

15.68%

16.73%

15.97%

19.17%

19.12%

20.83%

18.72%

16.6%

%of industry

8.43%

14.09%

11.54%

13.93%

14.66%

14.05%

16.50%

16.51%

17.89%

15.95%

14.4%

Intermediation

86.3%

64.7%

97.9%

68.0%

63.6%

63.1%

59.3%

52.7%

36.4%

44.7%

63.7%

7681

8688

7570

6079

9581

10651

12871

10651

5520

6646

8593.8

%of Sample

46.0%

45.3%

37.1%

40.9%

43.8%

39.8%

40.0%

32.8%

22.5%

21.0%

36.9%

%of industry

30.0%

32.1%

25.2%

29.6%

32.7%

29.7%

29.9%

23.7%

13.7%

13.1%

26.0%

fixed Assets
%of Sample

1491

1769

2118

1759

2239

2421

2033

2082

1439

1393

1874.4

64.74%

62.58%

66.67%

67.32%

64.04%

63.93%

58.69%

52.01%

41.65%

34.29%

57.6%

%of industry

52.51%

56.09%

60.06%

59.83%

58.03%

58.80%

52.67%

45.48%

35.53%

28.55%

50.8%

13452

15852

15687

13850

18761

25116

24381

31360

35557

41094

23511

%of Sample
%of industry

50.24%

49.61%

49.89%

46.93%

47.80%

49.94%

46.21%

47.11%

46.31%

47.35%

48.1%

41.03%

44.40%

41.62%

41.69%

41.89%

43.94%

39.79%

40.68%

39.79%

40.33%

41.5%

Intermediation

57.1%

54.8%

48.3%

43.9%

51.1%

42.4%

52.8%

34.0%

15.5%

16.2%

41.6%

Loans

16686

19162

20398

14877

21889

26773

32207

32460

24517

31723

24069.2

%of Sample

100.0%

100.0%

100.0%

100.0%

100.0%

100.0%

100.0%

100.0%

100.0%

100.0%

100.0%

%of industry
fixed Assets

65.2%

70.8%

68.0%

72.3%

74.7%

74.6%

74.8%

72.1%

61.0%

62.3%

69.6%

2303

2827

3177

2613

3496

3787

3464

4003

3455

4062

3318.7

%of Sample

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.0%

%of industry

81.11%

89.64%

90.10%

88.87%

90.61%

91.97%

89.74%

87.44%

85.31%

83.24%

87.8%

Deposits
%of Sample

26775

31956

31442

29511

39251

50292

52756

66567

76773

86785

49210.8

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.00%

100.0%

%of industry

81.66%

89.50%

83.42%

88.83%

87.64%

87.98%

86.10%

86.34%

85.91%

85.18%

86.3%

Intermediation

62.3%

60.0%

64.9%

50.4%

55.8%

53.2%

61.0%

48.8%

31.9%

36.6%

52.5%

Loans

25611.5

27061.3

29997.7

20566.1

29305.1

35905.9

43037.3

45019.0

40206.0

50919.0

34762.89

Fixed Assets
Deposits
Intermediation

2839.3

3153.7

3526.2

2940.2

3858.2

4117.6

3860.0

4578.0

4050.0

4880.0

3780.321

32787.0

35705.3

37693.0

33223.2

44788.1

57164.9

61272.6

77097.0

89361.0

101884.0

57097.6

78.1%

75.8%

79.6%

61.9%

65.4%

62.8%

70.2%

58.4%

45.0%

50.0%

64.7%

Deposits

State

Loans

Industry

Deposits

372


Appendix 11: Table 1 Non-parametric Yearly Average Technical efficiency scores and Returns to Scale Turkish banks

<table>
<thead>
<tr>
<th>Year</th>
<th>CRS</th>
<th>VRS</th>
<th>Scale</th>
<th>No. of Banks/ % of total Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS</td>
<td>VRS</td>
<td>CRS</td>
<td>DRS</td>
</tr>
<tr>
<td>1991</td>
<td>0.44</td>
<td>0.73</td>
<td>0.61</td>
<td>3</td>
</tr>
<tr>
<td>1992</td>
<td>0.62</td>
<td>0.84</td>
<td>0.74</td>
<td>5</td>
</tr>
<tr>
<td>1993</td>
<td>0.53</td>
<td>0.85</td>
<td>0.63</td>
<td>3</td>
</tr>
<tr>
<td>1994</td>
<td>0.73</td>
<td>0.89</td>
<td>0.83</td>
<td>8</td>
</tr>
<tr>
<td>1995</td>
<td>0.65</td>
<td>0.76</td>
<td>0.85</td>
<td>7</td>
</tr>
<tr>
<td>1996</td>
<td>0.70</td>
<td>0.82</td>
<td>0.85</td>
<td>10</td>
</tr>
<tr>
<td>1997</td>
<td>0.62</td>
<td>0.70</td>
<td>0.89</td>
<td>4</td>
</tr>
<tr>
<td>1998</td>
<td>0.57</td>
<td>0.66</td>
<td>0.87</td>
<td>7</td>
</tr>
<tr>
<td>1999</td>
<td>0.47</td>
<td>0.66</td>
<td>0.72</td>
<td>6</td>
</tr>
<tr>
<td>2000</td>
<td>0.49</td>
<td>0.69</td>
<td>0.71</td>
<td>6</td>
</tr>
</tbody>
</table>

Average 0.58 0.75 0.76 6 22% 15 56% 6 22% 27
Appendix 12: Table 1 Kendall Correlation Rank for the DEA Efficiency Scores (Egyptian Banks)

<table>
<thead>
<tr>
<th>Year</th>
<th>tau-a</th>
<th>tau-b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>0.8167</td>
<td>1</td>
</tr>
<tr>
<td>1985</td>
<td>0.4600* 0.817</td>
<td>1</td>
</tr>
<tr>
<td>1986</td>
<td>0.6000* 0.6100* 0.817</td>
<td>1</td>
</tr>
<tr>
<td>1987</td>
<td>0.5433* 0.4267* 0.5767* 0.88</td>
<td>1</td>
</tr>
<tr>
<td>1988</td>
<td>0.6409* 0.5033* 0.6802* 1</td>
<td>1</td>
</tr>
<tr>
<td>1989</td>
<td>0.5200* 0.3667* 0.4600* 0.6500* 0.85</td>
<td>1</td>
</tr>
<tr>
<td>1990</td>
<td>0.6241* 0.4401* 0.5521* 0.7516* 1</td>
<td>1</td>
</tr>
<tr>
<td>1991</td>
<td>0.5786* 0.4245* 0.4898* 0.6802* 0.7361* 1</td>
<td>1</td>
</tr>
<tr>
<td>1992</td>
<td>0.4033* 0.3000* 0.3133* 0.4433* 0.5400* 0.6700* 0.88</td>
<td>1</td>
</tr>
<tr>
<td>1993</td>
<td>0.3121 0.25 0.243 0.3533* 0.3767* 0.4933* 0.6500* 0.85</td>
<td>1</td>
</tr>
<tr>
<td>1994</td>
<td>0.0833 0.007 -0.033 0.1033 0.107 0.19 0.2933* 0.3167* 0.6</td>
<td>1</td>
</tr>
<tr>
<td>1995</td>
<td>0.119 0.01 -0.048 0.1422 0.149 0.2714 0.4037* 0.4434* 1</td>
<td>1</td>
</tr>
<tr>
<td>1996</td>
<td>0.26 0.25 0.243 0.3533* 0.3767* 0.4933* 0.6500* 0.85</td>
<td>1</td>
</tr>
<tr>
<td>1997</td>
<td>0.3121 0.25 0.243 0.3533* 0.3767* 0.4933* 0.6500* 0.85</td>
<td>1</td>
</tr>
<tr>
<td>1998</td>
<td>0.0833 0.007 -0.033 0.1033 0.107 0.19 0.2933* 0.3167* 0.6</td>
<td>1</td>
</tr>
<tr>
<td>1999</td>
<td>0.119 0.01 -0.048 0.1422 0.149 0.2714 0.4037* 0.4434* 1</td>
<td>1</td>
</tr>
<tr>
<td>2000</td>
<td>0.26 0.25 0.243 0.3533* 0.3767* 0.4933* 0.6500* 0.85</td>
<td>1</td>
</tr>
<tr>
<td>2001</td>
<td>0.3121 0.25 0.243 0.3533* 0.3767* 0.4933* 0.6500* 0.85</td>
<td>1</td>
</tr>
</tbody>
</table>

### Appendix 12: Table 2 Kendall Correlation Rank for the SFA Efficiency Scores (Egyptian Banks)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tau-a</th>
<th>Tau-b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1985</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1986</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1987</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1988</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1989</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1990</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1991</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1992</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1993</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1994</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1995</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1996</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1997</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1998</td>
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</tr>
<tr>
<td>1999</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2001</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2002</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Notes:
- Significance levels for Kendall's tau-a and tau-b are indicated as follows:
  - * indicates significance at the 0.05 level.
  - ** indicates significance at the 0.01 level.
Appendix 12: Table 3 Kendall Correlation Rank for the DEA Efficiency Scores (Turkish Banks)

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* Indicates statistical significance.
Appendix 12: Table 4 Kendall Correlation Rank for the SFA Efficiency Scores (Turkish Banks)

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