Malmquist Indices of Productivity Change in Turkish Banking Sector for the Period Between 2002 – 2011

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ABSTRACT

The aim of this study is to investigate the changes of efficiency in the Turkish Banking Sector for the years between 2002 – 2011. The Turkish economic system was hit by two serious financial crises in the late 1990s and early 2000s and as a result economic system collapsed in 2001. It is obvious that the strong finance sector is crucial for the economy as a whole and the banking sector is the most important part of a financial sector in Turkey. The financial resources are collected and allocated to the real sector through banking sector. In this context analysis of the financial sector, which will contribute to operate efficiently, is great of importance. Within this framework in the present study some different efficiency measuring techniques have been introduced. The widely used non-parametric Data Envelopment Analysis (DEA) is considered one of these techniques and Malmquist Productivity Indices (MPI) is used to investigate the levels and the changes in the efficiency.

Keywords: *Data Envelopment Analysis, Malmquist indices, Banking Sector, Efficiency.*

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ÖZET

2002-2011 Yılları Arası için Türk Bankacılık Sektörünün Malmquist İndeksi ile Verimlilik Ölçümü

Bu çalışmanın amacı Türk Bankacılık sisteminin etkinliğini 2002 – 2012 yılları arası için değerlendirmektir. Türkiye ekonomisi 1990'lı yılların sonu ve 2000'li yılların başında yaşanan iki ciddi krizden ciddi şekilde yara almıştır ve bunun sonucu olarak ekonomik sistem 2001 yılında büyük bir çöküntü yaşamıştır. Finans sektörün ekonomi açısından önemi ve bankacılık sektörünün bu sistem içerisindeki yeri tartışılmaz bir konudur. Finansal kaynakların reel sektöre bankalar aracılığı ile aktarılması, finansal sektörün etkinliğinin analizinin ne derece önemli olduğunun bir göstergesidir. Söz konusu çerçevede bu çalışmada çeşitli etkinlik ölçme teknikleri verilmiştir. Geniş çapta kullanılan parametrik olmayan veri zarflama analizi bu tekniklerden biridir ve Malmquist etkinlik indeksi etkinliğin seviyesini ölçmek ve değişimleri analiz etmek amacı ile kullanılmıştır.

Anahtar Kelimeler: .

1. INTRODUCTION

As economic environment changes in the global conjuncture, the role of financial institutions is becoming more and more important especially for developing economies. Particularly banks are primary actors in the financial sector (Akin and Zaim, 2009). It can be stated that a well-functioning banking system efficiency is an important determinant of economic growth in a country (Efendić, 2011). The supporting argument behind this statement lies on the fact that efficiency is the ability to achieve maximum output with minimum cost and thus banks have to survive by using their existing resources to achieve maximum output in a tough environment of increased competition.

However, studies in maintaining and measuring efficiency in the financial sector can be considered pretty new in Turkey. The idea of efficiency was ignored until 1980s. Profitability was considered mostly the major indicator in the economic competition (Seyrek and Ata, 2010). Nevertheless, Turkey fell into two banking crises in November 2000 and in February 2001.The major reasons of these two crises are poor banking practices, shortcomings in the assessment of credit risk, swift rise of nonperforming loans and structural weaknesses. In total, the cost of both crises to Turkish economy was US$ 50 billion and a fall in the gross domestic product of 9.4%. Consequently, the fragility of Turkish banking system manifested itself and twenty banks, which constitute 25 % of the banking sector, were taken over by the regulatory authority namely the Saving Deposit Insurance Fund (SDIF or TMSF).

Additionally, in 2001, the Banking Sector Restructuring Program was declared as a part of the Transition to Strong Economy Program to re-solve structural weaknesses and to increase confidence in the Turkish Banking System by maintaining transparency. The aim of the Banking Sector Restructuring Program was to privatize state banks, to solve the problems associated with SDIF banks, to reinforce private banks and to resolve nonfunctioning loan problems (Ozkan-Gunay and Tektas, 2006)

In this context, it can be argued that efficiency plays an important role in the re-strengthening of the Turkish banking system. In contemporary economic environment, efficient banks with lower costs and larger outputs can increase their profitability and thus raise their shareholder values (Seyrek and Ata, 2010). Therefore, some different efficiency measuring techniques have been introduced in order to measure bank efficiency. Data Envelopment Analysis (DEA) is one of these techniques. In this framework Malmquist Productivity Indices (MPI) is used in this study to investigate the levels and the changes in the efficiency. MPI is measured as 'technical efficiency change' or 'catch-up effect' and 'technical change' or 'innovation effect', which are the terms of DEA. The purpose of this study is to analyze the changes of efficiency in the Turkish banking sector especially due to the financial crises in 2001 and 2008.

2. METHODOLOGY

Productivity is one of the most important determinants of the firm's performance and the term productivity was first used by the French mathematician Quesnay. One possible measure of performance is a productivity ratio. Productivity ratio is mainly defined as the ratio of outputs that firms produced to the inputs it used (Kirikal, 2005).

2.1. Data Envelopment Analysis (DEA)

DEA nowadays has become popular method to measure financial efficiencies. Charles Cooper and Rhodes invented a non-parametric frontier estimation and called this methodology DEA. The term DEA is defined as a mathematical programming model applied to observational data that provides a new way of obtaining empirical estimates of relationships, such as the production functions and/or efficient production possibility surfaces. (Charnes et al., 1978). DEA assumes that there are no random fluctuations, so that all deviations from the estimated frontier represent inefficiency.

Data Envelopment Analysis (DEA) gives a solution to the problem of multiple inputs - multiple outputs, which could not be solved by the parametric stochastic frontier. DEA converts multiple inputs and outputs into scalar measure of efficiency. Mainly, DEA method maximizes the ratio of total weighted of output to total weighted of

inputs for a decision-making unit (DMU) (Wallace, 2009). The best DMUs (identified by the DEA) in its set may not be the best performer when similarly evaluated in other sets of units/organizations. DEA compares organizations' observed outputs and inputs, identifies the relatively 'best practice' units to determine the 'efficient frontier' (Mercan and Reisman, 2003).

A DEA model can be constructed either to minimize inputs or to maximize outputs. An input oriented model aims at reducing the input amounts as much as possible while keeping at least the present output levels, while an output oriented aims at maximizing output levels without increasing use of inputs. The focus on costs in banking and the fact that outputs are inclined to be demand determined means that input-oriented models are most commonly used (Tripe, 2005).

2.2. Malmquist Productivity Indices and its Decomposition

The measurement of the productivity level or indices is easy when a single output is produced from a single input (partial productivity). But companies like banks usually produce many outputs from many inputs. With the Malmquist productivity change indices, it is possible to measure productivity change over time or productivity change between firms. In 1953, Sten Malmquist (1953), a Swedish economist and statistician, in its originated paper used a quantity index for use in consumption analysis. Later, Caves, Christensen and Diewert (1982) developed Malmquist's idea for production analysis and they named their productivity change indices after Sten Malmquist (Kirikal, 2005). It is an index, which represents total factor productivity (TFP) growth of a bank or decision - making unit. The Malmquist indices (MI) basically measures efficiency change over time. It is measured as the product of catch - up or recovery and frontier - shift or innovation terms, both coming from the DEA technologies. MI has been studied and developed by many researchers like Färe and Grosskopf (1992), Färe, Grosskopt, Lindren and Roos (1989, 1994), Tatjé and Lovell (1995), Bjurek (1996), Färe, Grosskopf and Russell (1998) and Thrall (2000).

One important feature of the Malmquist productivity indices is that it can be decomposed into two components: technical efficiency change and technical change.

2.2.1. Malmquist Multifactor Productivity Indices

The Malmquist productivity indices measures productivity differences between two firms or one firm over two-time periods. To measure technical efficiency changes and technological changes over the period in question, a decomposed Malmquist productivity indices based on ratios of output distance functions is used (Dacanay III, 2007).

Malmquist Indices (MI) uses panel data to derive a measure of total factor productivity change, which can in turn be broken down into change in technical efficiency, relative to the efficient frontier and technical change, which would cause

the efficient frontier to shift (Coelli, 1998).

The first component of MI's (the catch-up effect) is calculated by the efficiencies being measured by the distances from the respective frontiers and is given by following equation (Dacanay III, 2007):

$$C = \frac{\delta^t((x_0, y_0)^t)}{\delta^s((x_0, y_0)^s)}$$

In this equation x and y show the input and output vectors, respectively. Catch up effect does not allow the inclusion of input prices, hence the computed score is technical and not allocative efficiency. The subscript $_0$ designates the DMU number; and, δ^s and δ^t represent the efficiency score for the periods s and t frontier technologies, respectively. Therefore, catch up effect, C, is measured by the ratio of the efficiency of $(x_0,y_0)^t$ with respect to period t technological frontier and the efficiency of $(x_0,y_0)^s$ with respect to period s frontier. When C > 1, it indicates progress in the relative efficiency from period s to t, while C = 1 and C < 1 indicate no change and regress in efficiency, respectively (Dacanay III, 2007).

MI's second component is the frontier shift (innovation) effect or technological change. It is taken into account in order to fully evaluate the productivity change since the catch-up effect is determined by the efficiencies being measured by the distances from the respective frontiers. The frontier shift effect formula is given as follows (Dacanay III, 2007):

$$F = \left[\frac{\delta^s((x_0, y_0)^s)}{\delta^t((x_0, y_0)^s)} \times \frac{\delta^s((x_0, y_0)^t)}{\delta^t((x_0, y_0)^t)}\right]^{1/2}$$

The frontier shift effect F > 1 indicates progress in the frontier technology around the DMU0 from period s to t, while F =1 and F <1 indicate the status quo and regress in the frontier technology, respectively. The product of the catch up effect, C, and frontier shift effects, F, are the Malmquist indices and is given by the Formula (Dacanay III, 2007):

$$MI = \left[\frac{\delta^s((x_0, y_0)^t)}{\delta^s((x_0, y_0)^s)} \times \frac{\delta^t((x_0, y_0)^t)}{\delta^t((x_0, y_0)^s)}\right]^{1/2}$$

This formula also provides to understand ratio of geometric means of two efficiency types. The first one is efficiency change which is measured by period s technology and the other one by period t technology. If the value of MI is greater than one, it points out a progress in the multi factor productivity of the DMU from period s to t, while zero and less than one indicate the status quo and decay, respectively. MI equation is the solution of the linear programming which is given as follows (Dacanay III, 2007):

$$[\delta^s(x_0, y_0)^t]^{-1} = max_{\phi,\lambda}\phi$$

$$\text{St } -\phi_{it} + Y_s\lambda \geq 0 \quad -\phi_{it} + Y_s\lambda \geq 0$$
$$-x_{it} + X_s\lambda \geq 0$$
$$\lambda \geq 0$$

where ϕ is scalar and λ is Ix1 vector of constants. X and Y are input and output vectors, respectively. x and y show the amounts of the i^{th} input consumed and output generated by the $DMU_{0,}$ respectively. And the indices s and t indicate the periods.

The Malmquist Indices has become increasingly popular and widely used for financial markets since its first application to banks (in Norway) by Berg et al (1992). It has been used also by Wheelock & Wilson (1999) and Alam (2001) for the United States market and Avkiran (2000), Sathye (2002) and Neal (2004) for the banks in Australia. Studies have typically looked at several years and have found relatively small changes in both efficiency and technology (Tripe, 2005).

3. DEA Efficiency Analysis of Banks

Effective and efficient functioning of the banking sector is of great importance for the Turkish economy. Banking sector assumes the role of financial intermediation that decides the distribution of resources. Thus the banking sector undertakes a key role in economic development of the country (Aydogan, 1989).

The crisis of 2001 in Turkey led to a significant transformation in economic policies, and a new economic program was put into effect. This program involved a reformation, particularly in the banking sector. The main clauses of banking reform can be summarized as follows: Issuing public bonds to public banks in return for task - related losses; rapid disposal of banks under the control of Saving Deposit Insurance Fund (SDIF); encouraging private banks to merge; and intensification of government control over the Banking Law (Inan, 2004).

3.1. Data

Statistical Report by the Bank Association of Turkey was used as data source. The analysis includes the period between 2002 and 2011. Since Turkish Banking system crashed in 2001, the data from mentioned year deformed the analysis. Because of this reason the

data of the year 2001 was neglected. The biggest 10 Banks were considered in that study and these banks sampled for the year 2011 account for 87,1 percent of total banking asset in the year. Table 1 presents market shares of Banks in 2011. To examine the data, Non- Interest Income (Net)/Total Assets, Interest Income/Total Assets and Total Income/ Total Expenses were used as outputs, and Other Operating Expenses/Total Assets, Other Operating Expenses/Total Operating Income and Interest Expense Total Asset as inputs. The analysis was implemented in DEA-Solver Pro 5.0.

Table 1: Market Shares of Banks in 2011

Toplam Assets	**2011**
Türkiye İş Bank	13.9
Türkiye Cumhuriyeti Ziraat Bank	13.8
Türkiye Garanti Bank	12.6
Akbank	11.5
Yapı ve Kredi Bank	9.3
Türkiye Halk Bank	7.9
Türkiye Vakıflar Bank	7.7
Finans Bank	4.0
Türk Ekonomi Bank	3.3
Denizbank	3.1
Total	87.1

3.2. Empirical Findings

Cumulative Malmquist indices were calculated under the assumption of constant returns to scale technology. Table 2 summarizes productivity change results, that is, the evolution of the Malmquist indices (MI), as well as its catch-up (C) and technological change (F) components.

Table 2: The Malmquist indices summary of bank means

Banks	Catch-up	Frontier	Malmquist
Türkiye Cumhuriyeti Ziraat Bank	1.024	0.983	1.007
Türkiye Halk Bank	0.969	1.004	0.968
Türkiye Vakıflar Bank	1.041	1.012	1.052
Akbank	0.950	1.038	0.987
Türk Ekonomi Bank	0.989	0.979	0.966
Türkiye Garanti Bank	1.074	1.002	1.069
Türkiye İş Bank	1.090	0.997	1.051
Yapı ve Kredi Bank	1.050	0.978	0.995
Denizbank	1.059	0.967	1.023
Finans Bank	1.048	1.004	1.007
Average	1.029	0.996	1.013
Max	1.090	1.038	1.069
Min	0.950	0.967	0.966
SD	0.046	0.020	0.036

Malmquist productivity indices can be interpreted as a measure of total factor productivity growth (Kirikal, Sorg and Vensel 2004). Within this context Turkish Banking Sector has a 1.3 % productivity increase at average. Among these banks, Halk Bank, Akbank and Turk Ekonomi Bank and Yapi Kredi Bank have decrease where Halk Bank is state-owned bank. The results suggest that Garanti Bank experienced an average of 6.9 percent annual productivity growth rate. As depicted in Table 2, Turkiye Vakiflar Bank, Turkiye Garanti Bank and Finans Bank have positive values for both catching-up effect and technological effect. That means these banks are both efficiently operated and are technically efficient which indicated innovations through shift of the best practice.

Table 3: Changes of Malmquist Indices from 2002 to 2011

	Catch-up	Frontier	Malmquist
Türkiye Cumhuriyeti Ziraat Bank	1.216	0.713	0.867
Türkiye Halk Bank	0.673	0.812	0.546
Türkiye Vakıflar Bank	1.391	0.957	1.331
Akbank	0.585	1.276	0.747
Türk Ekonomi Bank	0.884	1.105	0.977
Türkiye Garanti Bank	1.727	0.967	1.670
Türkiye İş Bank	1.594	0.925	1.473
Yapı ve Kredi Bank	0.896	0.921	0.825
Denizbank	1.579	0.857	1.354
Finans Bank	0.845	0.962	0.813
Average	1.139	0.950	1.060
Max	1.727	1.276	1.670
Min	0.585	0.713	0.546
SD	0.415	0.155	0.369

When the state owned banks are examined, it is explicitly observed that Vakiflar Bank improved both efficiently and technologically whereas Turkiye Halk Bank worsened sharply from 2002 until 2010. However, the results show that this sharp decrease is because of the decrease while passing from 2002 to 2003 by nearly 40% catching-up and 45 % Malmquist productivity indices. The negative effects of 2001 Banking Crisis manifest itself in these points. As it is seen in Figure 1, although the 2008 global crisis, in recent years indices have better values in general. These findings show that the Turkish Financial Sector has taken the crucial steps after the Financial Crisis in 2001 and regulated its structure.

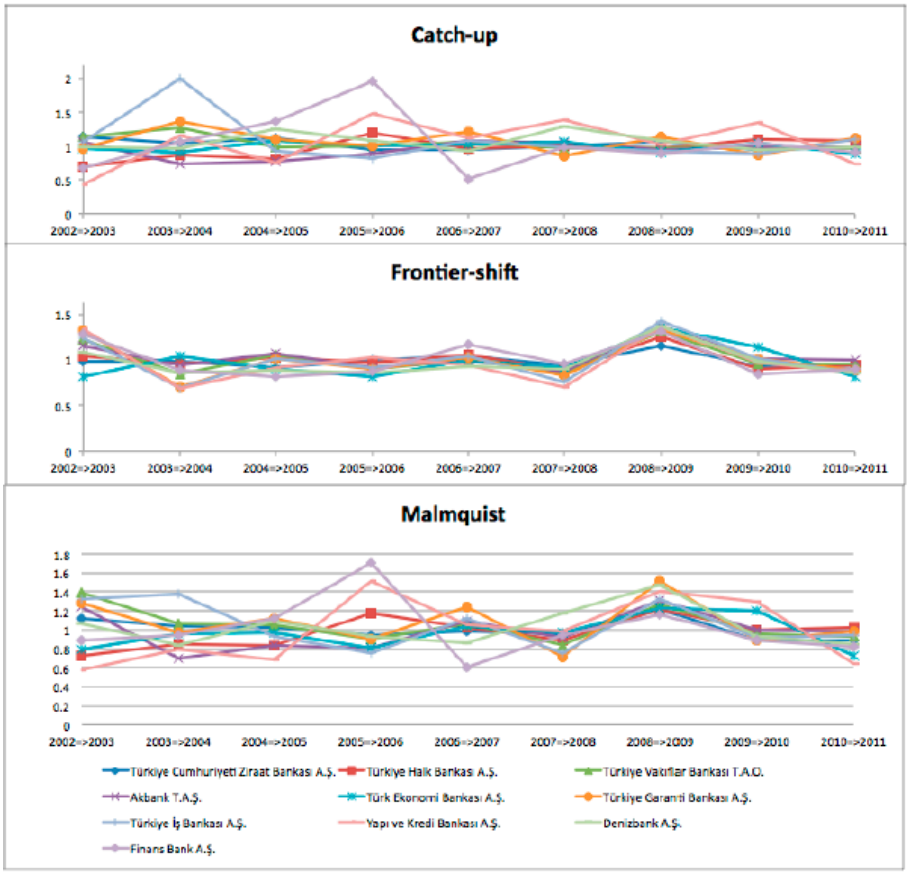

Figure 1: Malmquist Indices by Banks

4. DISCUSSION

Malmquist Productivity Indices is used to investigate the levels of and the changes in efficiency. In this study, the Malmquist indices of productivity change in Turkish Banking Sector is measured for the period between 2002 and 2011.

After the global financial crisis in 2008, the developed countries' financial systems have been badly affected. However sharp decreases in efficiency and technology that occurred after the crises in 2000 and 2001, did not emerge after the global crisis in 2008. According to the empirical findings, Turkish banks have a 1.3% productivity increase at average. In that context, it can be claimed that crucial steps are taken after the banking crises in 2000 and 2001 and the banking sector kept its strong position after the global crises of 2008.

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