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Efficiency, Productivity and Stock Performance: Evidence from the Turkish Banking Sector

Summary: This paper investigates the link between stock performance of the listed commercial banks in the Turkish stock exchange and three measures of bank performance, such as technical efficiency, scale efficiency and productivity for the period 1998-2008. The relationship between efficiency and stock returns is investigated by running a regression of stock returns on measures of performance and some bank specific variables. The results indicate that the changes in three measures of performance have positive and significant effect on stock returns, suggesting that stocks of technical efficient, scale efficient and productive banks tend to outperform their inefficient and unproductive rivals.

Key words: Stock returns, Technical efficiency, Productivity, Scale efficiency, Turkish banking.

JEL: G21, D24.

The main objective of the financial institutions is to maximize the shareholders' wealth. Banks, as a hearth of the financial system in many countries, share the same objective. Stock returns denote the measure whether banks are creating value for shareholders. It is expected that efficient and productive banks should create higher stock returns since such information generate expectations to the investors for better future financial results hence higher stock prices and earnings.

The efficiency of banking sector has received a great deal of attention in the literature especially after the structural changes such as deregulation, liberalization and introduction of new technologies took place in the banking sectors (see for example, Allen Berger and David Humphrey 1991; Berger 1993; Claudia Girardone, Philip Molyneux, and Edward Gardener 2004; Jan-Egbert Sturm and Barry Williams 2004; Steven Fries and Anita Taci 2005; Adnan Kasman and Canan Yildirim 2006; Evan Kraft, Richard Hofler, and James Payne 2006; Kang Park and William Weber 2006; Fundra Sensarma 2006). There are also a number of studies in the literature dealing with shareholder value (see for example, Gerald Garvey and Todd Milbourn 2000; Mary Barth and William Beaver 2001; Gary Biddle, Peter Chen, and Guochang Zhang 2001; Robert Holthausen and Ross Watts 2001; Koji Ota 2002). However, there have been only a few studies that link these two lines of research. Considering the substantial changes that have been taken place in the structure and competitive environment of the banking sectors, the efficiency, productivity and shareholder val-

ue creation of banking business are expected to be affected by these developments. Hence the analysis of the relationship between efficiency and shareholder value is especially relevant for commercial banks.

The aim of this study is to present an insight into how bank efficiency and productivity are linked to value creation in the Turkish banking system. The Turkish financial system has undergone significant legal, structural, and institutional changes as a result of financial liberalization program since the beginning of 1980s. The main objective of the program was to develop a sound, stable and efficient financial system by fostering competition in the banking market, which dominates the financial system. Elimination of restrictions on market entry, the abolition of directed credit policies, liberalization of deposits and credit interest rates, and adoption of international banking regulations in the banking industry were the significant changes in the last two decades. The Turkish financial system experienced two major financial crises in 1994 and 2001. After the crisis of 2001, the new macroeconomic environment led to important changes in the banking sector. Following the implementation of the Banking Sector Reconstruction Program which has significantly reshaped the industry, the number of banks, branches and employees were reduced. Moreover, the new legal and economic environment, and Turkey's candidacy for the European Union (EU) have increased the attractiveness of the banking industry to foreign investment, particularly from the EU-15 member countries. At the end of 2009, there were 32 commercial banks operating in Turkey. Currently, 13 commercial banks are publicly listed on the Istanbul stock exchange. Most of the listed banks are the larger banks operating in the banking industry and operating all regions of Turkey.

The motivation for our study is three-fold. First, although a few studies investigated the efficiency of Turkish banks previously none of them examined the link between efficiency and share performance (see for example, Ihsan Isik and Kabir Hassan 2002, 2003; Kasman 2003, 2005). Second, the experience of Turkey may constitute an opportunity to shed some light on the issue of efficiency and shareholder value since the Turkish banking system has experienced notable transformations during the period under study. Moreover, the available evidence on the relationship between share performance and efficiency is very limited. Our study contributes in filling this gap. Third, to the authors' best knowledge, this is the first paper that investigates the relationship between three measures of performance (productivity, efficiency, and scale economies) and shareholder value in the same study.

Our analysis is conducted in three steps. We first calculate the annual share price returns of the listed commercial bank operating in Turkey. Then we calculate the technical and scale efficiency of the banks with data envelopment analysis (DEA) and measure productivity change with the Malmquist TFP index approach. Finally, we regress the annual share price returns on the annual changes of efficiencies and productivity changes while controlling for other bank specific traits.

The rest of the paper is organized as follows. Section 1 presents related literature. Section 2 describes the methodology. The data and empirical results are reported in Section 3. The paper's concluding remarks are provided in Section 4.

1. Related Literature

Only in recent years there has been a growing interest in studying the link between efficiency and shareholder value. Some of them are the cross-country study. For example, Pablo Fernandez (2002) studies the relationship between the productivity change and bank stock performance using a panel of 142 banks operating in eighteen different countries. His study covers the period of 1989-1998 and estimate the productivity change by using DEA approach. The results indicate that market returns and efficiency are strongly positively related. Elana Beccalli, Barbara Casu, and Claudia Girardone (2006) estimate cost efficiency by employing DEA approach and Stochastic Frontier Approach (SFA) for a panel of European listed banks (France, Germany, Italy, Spain and the UK) in 1999 and 2000. They used deposits, loans and securities as outputs and labor and capital as inputs. Their results indicate that changes in the prices of bank shares reflect percentage changes in cost efficiency, particularly those derived from DEA. More recently Aggeliki Liadaki and Chrysovalantis Gaganis (2010) study the relationship between the stock performance and efficiency of 171 EU listed banks operating in 15 EU markets over the period 2002-2006. They use SFA methodology to estimate the cost and profit efficiency of sampled banks and find that only the change in profit efficiency has a positive and significant impact on stock prices.

A few studies examine individual countries. For example, Sing Chu and Guan Lim (1998) study the relative cost and profit efficiency of a panel of six listed banks in Singapore during the period 1992-1996. They find that listed banks have higher overall efficiency of 95.3% compared to profit efficiency of 82.6%. They also find that large Singapore banks have reported higher efficiency of 99.0% compared to 92.0% for the small banks. Their results indicate that scale inefficiency dominates pure technical inefficiency during the period of study and the percentage change in the price of bank shares reflect percentage change in profit rather than cost efficiency.

Joshua Kirkwood and Daehoon Nahm (2006) study the cost efficiency of Australian banks in producing banking services and profit between 1995 and 2002 by using DEA. Their findings indicate that the major banks have improved their efficiency in producing banking services and profit, while the regional banks have experienced little change in the efficiency of producing banking services and a decline in the efficiency of producing profit. They also find that change in bank efficiency is reflected in stock returns.

Fadzlan Sufian and Muhamed-Zulkhibri Majid (2006) study the cost and profit efficiencies of Malaysian banks that are listed on the Kuala Lumpur Stock Exchange (KLSE) during the period 2002-2003. Their empirical results indicate that the cost efficiency of Malaysian banks is on average significantly higher compared to profit efficiency. Their results also suggest that the large banking groups on average are more cost efficient while the smaller banking groups are more profit efficient. Their results indicate that the stock prices of Malaysian banks react more towards the improvements in profit efficiency rather than the improvements in cost efficiency.

Isidoro Guzman and Carmelo Reverte (2008) empirically investigate the relationship between efficiency and productivity changes and shareholder value of a

sample of listed Spanish banks over the period 2000-2004. To measure changes in efficiency and productivity they use the Malmquist nonparametric technique. Their results indicate that that those banks with higher efficiency and productivity changes have a higher shareholder value, even after controlling for the impact of traditional measures of performance, such as return on assets.

Fotios Pasiouras, Liadaki, and Constantin Zopounidis (2008) examine the association between the efficiency of Greek banks and their share price performance for the sample of ten listed commercial banks for the period 2001-2005. They use DEA to estimate the efficiency of the banks and find that the average technical efficiency under the constant returns to scale is 93.1% and increases to 97.7% under variable returns to scale. Their results also indicate a positive and statistically significant relationship between annual changes in technical efficiency and share price returns. Changes in scale efficiency, on the other hand, have no impact on share price returns.

Sufian and Majid (2009) study the relationship between the efficiency of listed Chinese banks and its share price performance for the period 1997-2006. They employ DEA methodology to estimate the efficiency of banks. Their results suggest that the large banks have higher technical and pure technical efficiency levels compared to small and medium sized banks while the medium sized banks have higher scale efficiency. They also find that bank efficiency contributes significant information towards share price returns beyond that provided by financial information.

2. Methodology

2.1 Efficiency

In this study, efficiency is measured using DEA methodology, which adopts a mathematical programming technique to measure the relative efficiency of banking firms in the sample. The DEA efficient frontier is determined by connecting the best-practice banks in the sample through piecewise linear combinations that lie over the observations. All deviations from the efficient frontier represent inefficiency since the DEA assumes no random fluctuations. We use both the input-oriented and output-oriented DEA models. The input orientation seeks to identify technical inefficiency as a proportional reduction in inputs usage. The output orientation, however, seeks to identify technical inefficiency as a proportional increase in output production. The input-oriented VRS specification, which adds convexity constraint to the CRS model, is specified as follows:

$$\begin{aligned} &\min_{\theta,\lambda} \theta \\ &s.t. \\ &\theta x_i - X\lambda \geq 0 \\ &-y_i + Y\lambda \geq 0 \\ &\lambda \geq 0 \\ &N1'\lambda = 1 \end{aligned} \tag{1}$$

where Y and X represent the vector of outputs and inputs, respectively; θ is a scalar; λ defines the weight of each bank within the reference group to which is compared any particular observation in order to determine the distance to the efficient frontier; and $N1'\lambda = 1$ is the convexity constraint, where $N1$ is an $N \times 1$ vector of ones. The linear programming model must be solved N times, one for each banking firm in the sample. The solution, θ^*, is the measure of technical efficiency for the bank i. Bank i is technically efficient if $\theta^* = 1$. Scale efficiencies are calculated by dividing the CRS efficiency score by the corresponding score of the VRS model and retain values between zero and one. The scale efficiency measure for bank i provides information about the excessive use of inputs (and hence excessive costs) associated with operating at a non-optimal level of output. If scale efficiency is equal to one, the bank is operating at CRS, which is economically and socially optimal.

The output-oriented VRS specification is specified as follows:

$$\begin{aligned} &\max_{\phi,\lambda} \phi \\ &s.t. \\ &x_i - X\lambda \geq 0 \\ &-\phi y_i + Y\lambda \geq 0 \\ &\lambda \geq 0 \\ &NI'\lambda = 1 \end{aligned} \tag{2}$$

where ϕ is a scalar. The solution, ϕ^*, is the measure of technical efficiency for the bank i. Bank i is technically efficient if $\phi^* = 1$. It should be mentioned that the theoretical studies are inconclusive as to the best choice among these two alternative approaches. However, these two alternative approaches produce the same values under CRS.

2.2 Total Factor Productivity

In this study, the Malmquist index approach is used to measure total factor productivity (TFP) change in the banking firms in the sample. The Malmquist TFP index is one of the most commonly used methods in the literature to evaluate productivity change in financial institutions. The advantages of the Malmquist index are that it does not make assumptions about the optimizing behavior of the producers and it allows for inefficiency (Rolf Fare et al. 1994). Moreover, it does not rely on econometric estimation, but instead it uses a nonparametric approach similar to that used by DEA. The main advantage of using a deterministic nonparametric approach is that it places less structure on the frontier and is not stochastic. However, the main weakness of nonparametric approach is that it is deterministic and, with no random error, any departure from the efficient frontier is measured as inefficiency. Hence, it is likely to be sensitive to measurement errors. A nonparametric approach is used in this

present study because it is relatively less demanding (i.e., it works quite well with a small sample size) compared to a parametric approach.

The Malmquist index enables us to determine levels of change in productivity and technical efficiency between two sample periods. However, the method is non-transitive and therefore cannot be used to estimate cumulative impacts over time. The input-oriented Malmquist productivity index is defined as the geometric mean of M (see Fare et al. 1994):

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^t(x^t, y^t)}{D^t(x^{t+1}, y^{t+1})} \times \frac{D^{t+1}(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})} \right]^{0.5} \quad (3)$$

where D^t and D^{t+1} represent the distance functions with respect to the production frontier under the assumption of constant returns to scale at periods t and $t+1$, respectively. A value of greater than 1 indicates a positive TFP growth between periods t and $t+1$, while a value less than 1 indicates a decline. This formulation of the Malmquist index allows us to distinguish two components of the TFP change: efficiency change (movement towards the production frontier) and technical change (a shift of the production frontier). Following Fare et al. (1994), this decomposition can be specified as follows:

$$M\ (x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D^t(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})} \left[\frac{D^{t+1}(x^t, y^t)}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^{t+1}, y^{t+1})} \right]^{0.5} \quad (4)$$

The term outside the brackets in Equation (4) is referred to as technical efficiency change (TE), which measures the change in the efficiency of a bank relative to the best practice frontier. The term in brackets indicates the technical change (TC). Both components can be greater than, less than or equal to 1 similar to the Malmquist TFP index.

The distances of each data point relative to a common technology in TFP change are estimated using DEA models specified in Equation (1). We first calculate measures by solving DEA models under the assumption of CRS. As shown in Equation (4), if the production technology exhibits CRS there are only two sources of productivity growth: technical efficiency change and technical change. We then calculate measures by solving DEA models under the assumption of VRS. If the production technology exhibits VRS, there are two additional sources of productivity growth: pure technical efficiency change (PE) and scale efficiency change (SE). Hence, using this decomposition, the Malmquist TFP index can be denoted as follows:

$$M\ (x^{t+1}, y^{t+1}, x^t, y^t) = PE * SE * TC \quad (5)$$

2.3 Stock Performance

Stock performance is represented by cumulative annual stock returns (*CASR*), which is computed on the basis of monthly returns. The formula for the *CASR* is specified as follows:

$$CASR_t = ((1 + R_{M1}) * (1 + R_{M2}) * ..... * (1 + R_{M12})) - 1 \quad (6)$$

where R_{Mi} represents monthly stock return. The 12 months window is chosen due to the period covered by the financial reports.

To test whether the estimated scores of efficiency, productivity and scale efficiency change are significantly related to the stock performance after controlling for the impact of some firm-specific variables, the following panel data model is specified:

$$CASR_{it} = \beta_1 + \beta_2 X_{it} + \sum \delta_i BSV_{it} + \varepsilon_{it} \quad (7)$$

where X_{it} is the efficiency change (or productivity change or scale efficiency change) level for bank *i* in year *t*; BSV_{it} denote bank specific control variables (i.e. *lnTA*: natural log of total assets; *EQTA*: annual change in equity over total assets; *ROA*: annual percentage change in return on average assets) for bank *i* in year *t*.

The technical efficiency and scale efficiency changes in year *t* are computed as:

$$EFFCH_t = (eff_t - eff_{t-1}) / eff_{t-1} \quad (8)$$

where $EFFCH_t$ and eff_t stand for efficiency change and efficiency level in time *t*, respectively. Since the Malmquist TFP index is the measure of productivity change we do not use the above equation to compute productivity change.

3. Data and Empirical Results

3.1 Data

Our sample consists of all commercial banks publicly listed in the Turkish stock exchange over the period 1998-2008. Currently, thirteen commercial banks are listed in the stock exchange. Balance sheets and income statements of the sampled banks were obtained from the Turkish Banking Association. Monthly stock prices, however, were obtained from the IBS, a data vendor.

The measurement of outputs is crucial while carrying out an efficiency and productivity analysis. As in many service industries, defining a proxy for the banking firms' outputs have always been difficult. Following Leigh Drake, Maximillian Hall, and Richard Simper (2006), Pasiouras (2007), and Pasiouras, Liadaki, and Zopounidis (2008), we choose outputs and inputs on the basis of a profit oriented approach,

which defines revenue components as outputs and cost components as inputs. This is relevant since the findings of Chu and Lim (1998) suggest that the changes in the bank shares prices reflect percentage changes in profit rather than cost efficiency. Since we have only thirteen banks in the sample, we kept the number of inputs and outputs as small as possible. Timothy Coelli, Sai Prasada Rao, and George Battese (1999) state that using a large number of outputs and inputs with a small sample size would result in many firms appearing on the efficient frontier. Following Pasiouras, Liadaki, and Zopounidis (2008), one output and two inputs are defined. The output is the total income, which is defined as the sum of interest and non interest income. The two inputs are the interest expenses and total operating expenses (i.e. personnel expenses and other administrative expenses). Table 1 reports the summary statistics of the output, inputs, CASR, and total assets.

Table 1 Summary Statistics of Inputs, Output, Return, and Size

Banks in the sample	Interest expenses	Operating expenses	Total income	CASR	Total assets
Akbank	1892.406	788.318	4187.040	0.408	23927.440
	(1352.424)	(429.889)	(2341.509)	(0.910)	(17177.520)
Alternatifbank	114.525	52.607	200.275	0.180	6058.004
	(43.694)	(14.339)	(67.176)	(1.137)	(16664.735)
Denizbank	328.436	195.893	669.588	0.323	9132.903
	(285.358)	(171.957)	(590.433)	(0.883)	(3488.365)
Finansbank	571.827	325.039	1250.463	0.477	7316.958
	(365.720)	(249.988)	(874.890)	(1.073)	(6148.011)
Fortis	488.151	400.589	1039.366	-0.382	7503.758
	(154.154)	(68.167)	(279.834)	(0.323)	(1224.114)
Garantibank	1832.467	839.674	3531.346	0.367	24021.817
	(1104.387)	(446.257)	(2249.933)	(1.099)	(19025.995)
Halkbank	3580.180	490.907	4808.365	-0.149	34140.888
	(1450.437)	(185.198)	(1330.116)	(0.752)	(798.930)
Isbank	2219.494	1072.660	4613.153	0.313	30829.222
	(1577.730)	(471.559)	(2894.392)	(1.218)	(23430.340)
Sekerbank	283.856	147.628	530.794	0.298	2329.332
	(97.533)	(78.177)	(233.483)	(1.023)	(1578.797)
Tekstilbank	106.845	55.542	189.473	0.287	1212.832
	(45.897)	(19.204)	(69.009)	(1.207)	(655.971)
TEB	307.508	192.272	601.066	0.159	4701.450
	(266.286)	(152.848)	(474.412)	(0.743)	(3489.096)
Vakifbank	1747.463	556.404	2662.236	-0.146	30339.902
	(706.101)	(178.781)	(1475.019)	(0.456)	(6029.586)
Yapikredibank	1783.664	1073.681	3225.222	0.414	20126.172
	(811.512)	(786.671)	(1724.634)	(1.607)	(13366.889)
Overall	*1163.139*	*464.460*	*2092.847*	*0.280*	*14093.112*
	(1316.744)	*(477.933)*	*(2210.586)*	*(1.046)*	*(16589.295)*
Trend					
1998	750.228	199.240	1141.360	0.309	4318.934
	(1087.470)	(173.182)	(1275.488)	(1.436)	(3575.414)

1999	954.605	210.393	1407.204	3.066	4898.053
	(1481.689)	(183.097)	(1694.271)	(1.020)	(3991.967)
2000	782.638	308.422	1329.661	-0.538	5684.566
	(1261.392)	(255.815)	(1459.273)	(0.141)	(5000.471)
2001	1187.352	338.604	1565.970	-0.083	5693.113
	(1649.274)	(309.703)	(2023.056)	(0.286)	(5270.007)
2002	856.732	269.605	1434.436	-0.475	6667.239
	(891.444)	(220.399)	(1386.244)	(0.272)	(6322.889)
2003	925.219	387.669	1715.268	0.665	9357.303
	(850.327)	(327.993)	(1545.272)	(0.345)	(9128.771)
2004	880.191	452.175	1873.089	0.504	11407.988
	(727.614)	(348.724)	(1541.590)	(0.325)	(10752.234)
2005	945.300	652.075	2075.669	1.101	16522.632
	(821.810)	(684.034)	(1776.276)	(0.708)	(16064.791)
2006	1361.435	601.436	2649.210	-0.066	19194.873
	(1218.530)	(476.990)	(2249.692)	(0.222)	(18092.845)
2007	2140.608	878.514	4135.138	0.353	27737.860
	(1832.802)	(717.481)	(3527.482)	(0.496)	(23761.273)
2008	2010.218	810.932	3694.308	-0.663	28617.607
	(1647.913)	(615.262)	(3004.996)	(0.191)	(22509.929)

Note: Interest expenses, operating expenses, total income, and total assets are in million dollars. The figures in the parentheses are the standard deviations. The CASR stands for the cumulative annual stock returns.

Source: The Turkish Banking Association, the IBS and own calculations.

3.2 Empirical Results

The average calculated efficiency scores across banks and time are reported in Table 2. The efficiency scores are calculated under the assumptions of constant returns to scale (CRS) and variable returns to scale (VRS). For the CRS model, the results indicate an average efficiency of 84.1% for thirteen banks considered. However, for the VRS model, this average score is 90.4% for the input oriented specification. These results are consistent with the previous studies that the VRS specification generally produces higher efficiency scores than those of the CRS specification. Since Spearman rank-order correlation between two specifications is very high (99%) our analyses are based on the results of the input-oriented VRS specification. The results presented in Table 2 also indicate a wide range of efficiency scores across banks. Most banks display significant level of inefficiency ranging from 0% to 24.7%. The average efficiency scores fluctuate along the eleven years of our sample. Although there does not seem to be a clear trend, banks become more efficient in recent years.

The average scale efficiency scores for each bank and time are also reported in Table 2. The results indicate that an average bank operates under the optimum scale. The average scale efficiency is 93%.

Figure 1 presents the evolution of average efficiency scores under the CRS and VRS specifications. The results from the input orientation are analyzed. The mean efficiency for both specifications fluctuates along the eleven years of our sample. Although there does not seem to be a clear trend, the listed banks in Turkey have become more efficient in recent year. The CRS model produces lower estimates than

the VRS model because the latter envelope the data more closely than the former. Although the efficiency scores from the VRS model higher than the CRS model, the efficiency scores from both models show similar trends. As for the scale efficiency, the average score is always under one, suggesting that an average bank operated under the optimum scale during the sample period. As in the efficiency case, there does not seem to be a clear trend, banks becomes more scale efficient in recent years.

Table 2 Average Efficiency Scores (1998-2008)

		Input-oriented		Output-oriented	
Banks in the sample	**CRS**	**VRS**	**Scale**	**VRS**	**Scale**
Akbank	0.997	1.000	0.997	1.000	0.997
Alternatifbank	0.773	0.960	0.800	0.924	0.829
Denizbank	0.824	0.923	0.896	0.918	0.901
Finansbank	0.891	0.936	0.949	0.929	0.957
Fortis	0.854	0.867	0.985	0.871	0.980
Garantibank	0.809	0.829	0.977	0.861	0.940
Halkbank	1.000	1.000	1.000	1.000	1.000
Isbank	0.902	0.928	0.973	0.960	0.936
Sekerbank	0.815	0.881	0.919	0.862	0.940
Tekstilbank	0.753	0.957	0.792	0.939	0.811
TEB	0.802	0.883	0.913	0.877	0.921
Vakifbank	0.747	0.753	0.989	0.763	0.973
Yapikredibank	0.746	0.792	0.948	0.830	0.903
Overall	*0.841*	*0.905*	*0.930*	*0.904*	*0.927*
Trend					
1998	0.817	0.933	0.948	0.882	0.926
1999	0.837	0.873	0.962	0.885	0.945
2000	0.795	0.906	0.882	0.925	0.879
2001	0.667	0.835	0.821	0.827	0.816
2002	0.784	0.856	0.916	0.856	0.916
2003	0.768	0.865	0.896	0.873	0.887
2004	0.832	0.903	0.926	0.900	0.928
2005	0.907	0.939	0.964	0.939	0.963
2006	0.885	0.933	0.948	0.932	0.950
2007	0.937	0.947	0.983	0.946	0.985
2008	0.958	0.977	0.981	0.968	0.990

Source: Own calculations.

As seen in Figure 1, a sharp decline in efficiency scores occurred in year 2001. This is expected since a major financial crisis took place in February, 2001. The historically unstable macroeconomic environment, fragility in the banking system and poor banking supervision were the common factors of the financial crisis of 2001. The Turkish economy shrunk by 9.4% and the Turkish Lira was devalued significantly against the US dollar, and most of the Central Bank reserves were eroded in managing the crisis. The banking system, which is dominated the financial system, was the most affected by the crisis due to the high level of foreign currency dominated liabilities. Total assets of the banking industry decreased about 30% in US dollars terms (see Kasman 2003). The empirical results show the impact of financial crisis of 2001 on the efficiency levels. The efficiency levels of sampled banks decreased significantly in year 2001 and started to increase after 2002.

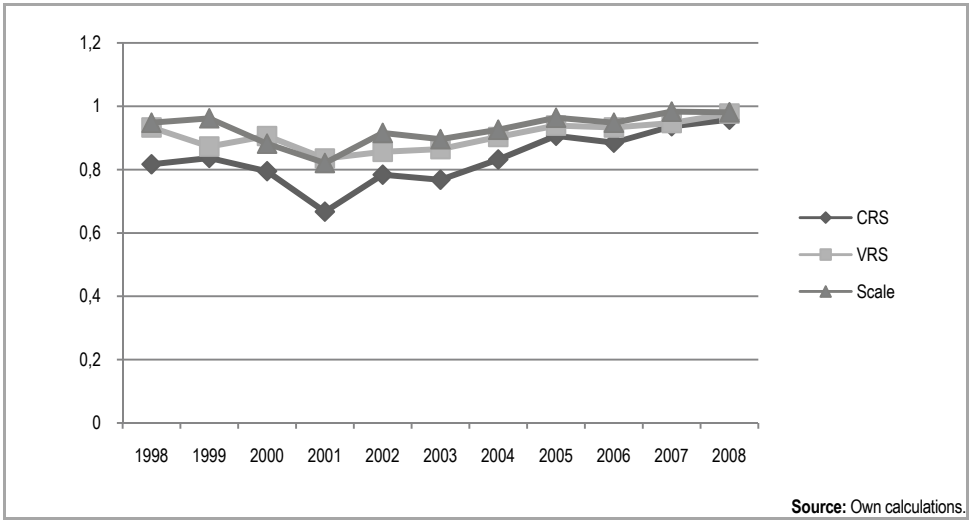

Figure 1 Efficiency Scores under the CRS and VRS Models and Scale Efficiency Score

The Malmquist total factor productivity (*TFP*) change for the listed banks in the Turkish banking system for the period 1998-2008 is reported in Table 3. It should be mentioned that the entries in each column of Table 3 are annual geometric means of results of individual banks. An index greater than one indicates a positive *TFP* growth while an index lower than one indicates a decrease of *TFP* over the sample period. Productivity change is then decomposed into technical efficiency change (*TE*) and technical change (TC), where $TFP = TE \times TC$. An improvement in *TE* is considered as the "catching-up", whereas an improvement in *TC* is a shift in the best-practice frontier. The *TE* is further decomposed into the scale efficiency change (*SE*) and pure efficiency change (*PE*) components ($TE = SE \times PE$). The main advantage of the decomposition is that it provides information on the sources of the overall productivity change in the banking sectors of the sampled countries.

The results in Table 3 indicate that about half of the sample banks seem to have experienced a significant productivity growth over the sample period. From an analysis of the decomposition of the Malmquist *TFP*, productivity growth in sampled banks seem to have been brought about mainly by a positive technical efficiency change, suggesting that sampled banks seem to have been able to exploit also some catching up effect.

As for the scale efficiency (*SE*) change, almost all sampled banks display positive scale efficiency change. Overall, the *TFP* growth fluctuates over the sample period. As seen in Table 3 and Figure 2, although there does not seem to a clear trend, banks become less productive in recent years. The analysis of the decomposition of the *TFP* index into its technical change (*TC*) and technical efficiency change (*TE*) components shows different trends. Whereas there seem to have been considerable efficiency changes over sample period, no clear trend seems to exist for technical change, which stays below one in several years but stays relatively steady over the sample period. As seen in Figure 2, the impact of financial crisis of 2001 on the *TFP*

and efficiency changes and technical change is clear. All scores decreased sharply in 2001.

Table 3 Total Factor Productivity of the Listed Banks (1998-2008)

Banks in the sample	Efficiency change	Technical change	Pure efficiency change	Scale efficiency change	*TFP change*
Akbank	1.001	0.995	1.000	1.001	0.996
Alternatifbank	1.064	0.976	1.039	1.040	1.045
Denizbank	1.006	0.926	1.000	1.009	0.932
Finansbank	1.008	0.968	1.005	1.001	0.978
Fortis	1.063	0.907	1.056	1.009	0.960
Garantibank	1.021	0.962	1.007	1.017	0.982
Halkbank	1.000	1.016	1.000	1.000	1.016
Isbank	1.046	0.957	1.008	1.042	1.000
Sekerbank	1.035	0.978	1.043	0.996	1.013
Tekstilbank	1.037	0.984	1.028	1.014	1.021
TEB	0.996	1.009	1.004	0.995	1.000
Vakifbank	1.066	0.993	1.066	1.001	1.050
Yapikredibank	1.032	0.977	1.030	1.008	1.007
Overall	*1.025*	*0.978*	*1.020*	*1.008*	*1.001*
Trend					
1998/1999	1.040	1.021	1.006	1.034	1.060
1999/2000	1.010	0.910	1.084	0.927	0.918
2000/2001	0.820	0.903	0.914	0.908	0.738
2001/2002	1.217	1.066	1.054	1.175	1.289
2002/2003	0.992	1.045	1.016	0.977	1.036
2003/2004	1.091	0.971	1.055	1.041	1.060
2004/2005	1.105	0.935	1.059	1.049	1.033
2005/2006	0.977	1.012	0.996	0.983	0.989
2006/2007	1.057	0.941	1.017	1.040	0.994
2007/2008	1.032	0.924	1.035	0.997	0.953

Source: Own calculations.

To investigate relationship between the efficiency change (or productivity change) and stock returns, we regress the *CASR* on the annual change in efficiency and some firm-specific variables. Since we have panel data, the OLS estimators will tend to be biased. Hence, we can estimate two alternative models of panel data: The fixed effects model and the random effects model. The fixed effects model assumes differences in intercepts across firms, whereas the random effects model assumes differences in error term. In choosing between two alternative models, we test for correlation between the individual effects and explanatory variables using the Hausman test. If the null of no correlation is rejected, the random effects model is not appropriate, and therefore the fixed effects model is preferred. Our Hausman test results suggest that the fixed effects model is better than the random effects model.

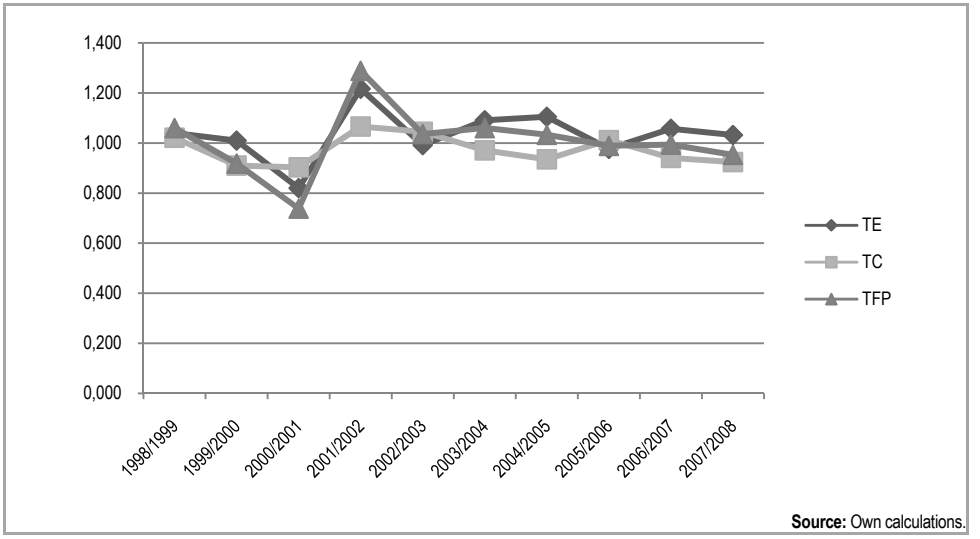

Figure 2 Evolutions of TFP Change, Technical Efficiency Change, and Technical Change

Table 4 reports the regression results for the technical efficiency, productivity and scale efficiency changes. The relationship between stock returns and efficiency change (or scale efficiency change) is investigated by using scores from the input orientation. The scores from the output orientation were also used in the analysis. The results are very similar. To conserve space they are not reported but available upon request from the authors. The results in the second column of Table 4 indicate that change in efficiency has a positive and statistically significant coefficient, implying that efficiency appears to be more important than traditional indicator of profitability, ROA. Positive coefficient suggests that efficient bank can generate more profits and there is an increased likelihood that it will continue to generate profits in the future. Moreover, efficiency is one of the indicators of quality that may allow banks to improve their profits compared to competitors. Since efficiency changes take input and output considerations into account during the optimization process they provide more information about the quality and the persistency of profits than changes in ROA.

The third column of Table 4 shows that the coefficient of change in productivity is positive and significant, suggesting that the stocks of productive banks tend to outperform their unproductive competitors. Significantly positive coefficient suggests that productive banks could improve their profits compared to competitors, and increase their survival chance in the industry. As for the change in scale efficiency, the fourth column of Table 4 shows that it has a positive and significant coefficient, suggesting that scale efficient bank operates at the optimum scale and it could generate more profits and returns relative to competitors. In addition, scale efficient banks can grow to become more profitable and increase its market shares, which allow them to continue to generate profits in the future.

Overall, our results suggest that the stocks of efficient and productive banks tend to outperform their inefficient and unproductive rivals. These results are also consistent with the findings of previous studies (see for example, Beccalli, Casu, and Girardone 2006; Guzman and Reverte 2008; Pasiouras, Liadaki, and Zopounidis 2008; Liadaki and Gaganis 2010), which found positive and significant relationship between efficiency (and/or productivity) changes and stock performance for the listed banks in several European countries. Moreover, as seen in Table 4, the scale efficiency variable has a greater effect on stock returns compared to the productivity and efficiency changes.

The models also include some control variables (size, risk and profitability). The result indicates that changes in return on asset are positively and significantly related to the stock returns in all three models. However, changes in equity over total assets and natural logarithm of total assets are negatively and significantly related to the stock returns, indicating that larger banks and banks that have higher capital adequacy ratios have lower returns. We also included a dummy variable in the regression model in order to control the impact of financial crisis of 2001 on the stock returns. The results indicate that the dummy variable is statistically insignificant, implying that the crisis does not seem to contribute in the explanation in stock returns. Hence, we dropped the dummy variable from the regression equation.

Table 4 Regression Results (1999-2008)

Variables	Change in efficiency	Change in productivity	Change in scale
Constant	6.311* (2.012)	6.306* (2.055)	5.873* (2.171)
Change in efficiency	1.949 ** (0.901)		
Change in productivity		1.573** (0.794)	
Change in scale efficiency			1.998** (1.008)
ROA	0.288* (0.091)	0.294* (0.092)	0.270* (0.094)
EQ	-0.335** (0.140)	-0.304** (0.137)	-0.297** (0.137)
LTA	-0.863* (0.211)	-0.809* (0.209)	-0.817* (0.201)
R^2	0.27	0.26	0.25
$\bar{R}^2$	0.17	0.16	0.14
Hausman Test	18.24 (d.f.4)	15.80 (d.f.4)	16.56 (d.f.4)

Note: * and ** denote significance levels at 1% and 5%, respectively. $\bar{R}^2$ denotes adjusted *R*-squared. *ROA, EQ,* and *LTA* stand for change in return on assets, change in the ratio of equity over total assets, and natural logarithm of total assets, respectively.

Source: Own estimations and calculations.

4. Conclusions

This paper investigated for the first time the relationship between the technical efficiency, total factor productivity and scale efficiency of the listed banks in the Turkish stock market and their stock returns for the period 1998-2008. The results indicate that the average technical efficiency over the sample period is 0.841 under the constant returns to scale, 0.905 under the variable returns to scale. Furthermore, the average scale efficiency is 0.930. As for the productivity change, the result indicates that there was no significant improvement during the sample period.

The results of paper indicate that the coefficients of the technical efficiency and scale efficiency changes are statistically significant and positively related to stock returns, suggesting that those with higher efficiency (technical and scale) changes have higher returns. As for the relationship between productivity changes and stock returns, the results indicate that the relationship is positive and statistically significant. Overall, the results of this paper suggest that efficient and productive banks tend to outperform their inefficient and unproductive rivals in the sector. That is, managerially efficient banks should generate more profits and greater shareholder returns. Hence, the results of paper provide helpful and important information to the researchers, shareholders and potential local and global investors.

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