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DETERMINATION OF THE EFFICIENCY OF THE TURKISH BANKS AND OUTPUTS' CONTRIBUTIONS TO THE EFFICIENCY AND TFP: DEA WITH PANEL REGRESSION[1]

TÜRK BANKACILIĞINDA ETKİNLİĞİN BELİRLENMESİ VE ÇIKTILARIN ETKİNLİK VE TFV ÜZERİNE ETKİSİ: PANEL REGRESYONLU VZA ANALİZİ

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ABSTRACT

In this study, the Technical Efficiency and the Allocative Efficiency Scores of 23 commercial banks operating in Turkey between 2003 and 2012 were obtained by use of the Data Envelopment Analysis. In the CCR model analysis; while 3 banks did not have Technical Efficiency for the first years, this number doubles for 2012. Whereas only 5 banks were efficient in terms of Allocative Efficiency for the first year, this number goes down to 4 in the last year. As a result of the BCC model; while only one bank did not have Technical Efficiency at the beginning of the period, this number quadruples at the end of the period. This number for the Allocative Efficiency is 10 at the beginning of the period and 16 at the end of the period. Considering the CCR model, it is more significant in the estimation by using the panel data regression model in order to determine the effect of the outputs on the efficiency of the banks. The Malmquist Index is used for the Total Factor Productivity and it was found out that the productivity increased only at the rate of two thousandth (0.002) for all the enterprises for the period.

Keywords: *Non-Parametric Method; Panel Data; DEA; TFP; Banking*

ÖZET

Bu çalışmada Türkiye'de 2003-2012 yılları arasında faaliyet gösteren 23 bankanın Veri Zarflama Analizi ile Teknik Etkinlik ve Tahsis Etkinliği skorları elde edilmiştir. CCR modeli ile yapılan analizde ilk yıl için toplam 3 firma teknik etkin değilken 2012 yılı için bu sayı iki katına çıkmıştır. Tahsis

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etkinliği için ilk yıl için sadece 5 firma etkin iken son yıl için bu sayı 4'e düşmüştür. BCC modeli ile girdi yönelimli ve değişken getirili analizde dönem başında sadece bir banka teknik etkinliğe sahip değilken dönem sonunda bu sayı 4'e çıkmaktadır. Tahsis etkinliği için bu sayı dönem başında 10 ve dönem sonunda 16 olarak çıkmaktadır. Bankaların etkinliğine çıktıların etkisini belirlemek amacı ile Rastgele Etkiler Panel Regresyon modeli ile yapılan tahminde CCR modelinin daha anlamlı olduğu görülmüştür. Toplam Faktör Verimliliği için Malmquist Endeksi kullanılarak yıllar boyunca tüm işletmeler için Toplam Faktör Verimliliğinin sadece binde iki düzeyinde arttığı tespit edilmiştir.

Anahtar Kelimeler: *Parametrik Olmayan Metot; Panel Data; VZA; TFV; Bankacılık*

1. INTRODUCTION

Turkish banking system had a big loss of trust during the economic crisis in 1994 and this problem was partially solved by the recognition of 100% deposit protection by the Turkish Treasury. In 2000s, the increasing inflation and uncontrollable increase in the public debts forced to make some structural transformations. The number of banks[5], which were 79 at the beginning of this period, went down to 55 in 2003 and to 49 in 2010 (Coşkun et al., 2012).

Overvalued Turkish Lira (TL) and subsequent economic irregularities as results of the fixed exchange rate policy in a high inflationary environment caused the crisis in November 2000 and February 2001. After the crisis of February 2001, the Turkish Treasury had to pay off a nearly 19 billion dollar "business damage" bill for the public banks. For the private banks, the management and the ownership of 20 banks (12 of them between 2000 and 2002) were transferred to the Banking Regulation and Supervision Agency by the Saving Deposit Insurance Fund. Some of these banks were merged with others, some were able to go on business but the ownership was changed, and some lost their licenses and shut down. During this period, 100% protection for the deposits forced the Treasury to pay the damages of the private sector banks as well. Serious restrictions and regulations were adapted in the banking system in order to prevent such problems in the future.

The development of the Turkish banking sector for the last ten years which covers the term of the last government since the late 2002 in Turkey, comprise the subject of this study. Activities of the private, foreign and public banks operating in Turkey between 2003 and 2012 and their

[5] Total number of commercial banks was 62 in 1999 and 19 of them were foreign-invested banks. This number went down to 41, 13 of which were foreign-invested banks, in 2003.

progresses within the given period are also discussed[6]. Within this period, some banks' ownerships were changed and some others were even shut down. The banks analyzed in the study consist of 99% of the total trading volume.

Table 1 below provides information on the structure and the change of the 23 banks in Turkey. Out of 23 banks, 11 of them are private, 9 of them are foreign and 3 of them are state-owned banks. While the deposits to these banks were 155 billion TL in 2003, this amount reached 766 billion TL with a rise of around 400% in 2012. In the same period, the net asset value increased at the same rate. The rate of increase in the number of employees remained at a level of around 60%.

The deposits share of the private banks remained stable at the rate of 52% for the last ten years. While the deposits share of the foreign banks increased from 9% to 13%, this rate decreased from 39% to 35% for public banks. While the deposits share of the foreign banks increased by 44%, the decrease rate in public banks was 10%.

The share of the employees working in private banks remained stable at 51% for ten years. However, the share of the employees in foreign banks increased from 14% to 21%, but this rate decreased from 34% to 29% for the public banks. In short, 5 out of ten employees working in the Turkish banking sector work in a private bank, 3 worked in public banks and 2 worked in foreign banks. 22% of the deposits in 2003 and 16% in 2012 belonged to Ziraat Bank. At the beginning of this period, 20% and in 2012 13% of the employees belonged to the same bank. Isbank and Akbank follow Ziraat Bank in these aspects. Deutsche Bank appears in the list as the bank with the lowest deposits and employee number.

[6] The following changes were observed in the banks analyzed during the given period. Sitebank, which moved on as Bankeuropa as of the first quarter of 2003, was changed as Millenium Bank in the last quarter of 2006 and finally it has continued its existence as Fibabanka since the second quarter of 2011. Türk Dış Ticaret Bankası (Turkish Foreign Trade Bank) moved on as Fortis Bank as of the last quarter of 2005, and was merged with the Türk Ekonomi Bankası (TEB) as of the first quarter of 2011. Koçbank was merged with Yapı Kredi as of the last quarter of 2006. MNG Bank moved on as TurkLand Bank as of the first quarter of 2007. Oyak Bank continued its existence as ING Bank as of the fourth quarter of 2008. Tekfen Bank moved on as Eurobank Tekfen as of the first quarter of 2008 and then it has continued its existence as BurganBank since the last quarter of 2012.

Table 1. Some Figures about the Commercial Banks in Turkey for the Years 2003 & 2012

BANKS	NET ASSETS 2003	DEPOSITS 2003	PERSONEL PAYMENTS 2003	NUMBER of EMPLOYEES 2003	NET ASSETS 2012	DEPOSITS 2012	PERSONEL PAYMENTS 2012	NUMBER of EMPLOYEES 2012
Akbank	25731306	19103202	267496	9625	81838295	86104718	2589653	16072
Abank	979566	723658	23524	487	6857444	4176060	114001	1191
Anadolubank	1444327	1147913	59768	879	5980496	3921371	195301	1963
Fibabanka	100685	60103	15682	186	3582198	2689441	86734	532
Şekerbank	2518486	2059865	73834	3009	13578241	10137906	262077	3554
Tekstilbank	1020322	744747	23910	866	3418609	2715425	64995	852
Turkishbank	359602	290166	5539	184	863575	616814	19049	288
Teb	6631968	4725993	154650	4893	37475724	28726565	634396	9235
Garanti	19451324	14400740	754322	7971	133926932	87482419	2772294	17208
Türkiye İş Bankası	28212226	19561606	621060	15415	161022637	105383434	3042824	24580
Yapıkredi	26099862	18477991	453258	13701	104382239	68043940	2413358	14908
Sum Of Private	112549674	81295984	2453043	57216	552926390	399998093	12194682	90383
SumOfPrivate / GrandTotal	0,53	0,52	0,58	0,51	0,53	0,52	0,62	0,51
A&T Bank	126067	35589	12021	176	1489853	1029738	43976	268
Burgan Bank	557587	432417	19434	589	4193685	3264555	82226	962
Citibank	1175374	823895	52231	1119	7409809	5171532	174951	2123
Denizbank	4370644	3092064	71529	3086	38081429	26696342	569065	10368
Deutsche Bank	121284	0	25681	31	1058652	430740	25116	107
Finansbank	4676925	3635026	100250	3539	50608866	32921506	1342609	11330
Hsbc	3264702	2098536	160503	3439	19068172	14206411	511365	6023
Ing Bank	4195886	3513724	113145	3791	18908477	14430196	416108	5245
Tbank	217852	139444	6132	189	2380632	1879282	57553	498
Sum Of Foreign	18706321	13770695	560926	15959	143199575	100030302	3222969	36924
SumOfForeign / GrandTotal	0,09	0,09	0,13	0,14	0,14	0,13	0,16	0,21
Ziraat Bankası	46057835	33851826	655596	22440	158637835	118966304	1361181	23766
Halkbank	18950836	13820883	278004	8692	99774884	79973901	870456	14131
Vakıfbank	15482525	12698961	257539	7446	94881178	67242290	2168815	13064
Sum Of Public	80491196	60371670	1191139	38578	353293897	266182495	4400452	50961
SumOfPublic / GrandTotal	0,38	0,39	0,28	0,35	0,34	0,35	0,22	0,29
Grand Total	211747191	155438349	4205108	111753	1049419862	766210890	19818103	178268
Change In Private	1	1	1	1	4,91	4,92	4,96	1,57
Change In Foreign	1	1	1	1	10,40	7,26	5,75	2,31
Change In Public	1	1	1	1	4,39	4,41	3,69	1,32

In this study, the literature review is given in the following section. Then, a brief explanation of methodology for the data envelopment analysis (DEA), the MI, and the panel regression is presented in the section three. The empirical results of the analyses can be found in the section four. Finally, the conclusion and the suggestions are presented in the section five.

2. LITERATURE

The majority of the studies about banking efficiencies are done via the DEA and the MI. In the DEA analyses, a series of models in different time segments with various input and output variables are used to analyze the banks' efficiencies. As an econometric estimation method, the panel regression is also utilized in studies on banking efficiency.

Das and Ghosh (2006) investigate the efficiency of the Indian Banks over a ten year period from 1992 to 2002. They utilize 3 different approaches, namely intermediation approach; value added approach; and operating approach in order to define inputs and outputs of the analysis. Their findings suggest that the technical efficiency (TE) scores seem to be low and declining over the investigated period. The findings also suggest that, after the liberalization there was no improvement in the efficiency of the banks. The ownership status, level of non-performing loans, size, asset quality, and management are the determinants of the efficiency scores of the banks.

Staub et al. (2010) investigate the efficiency scores of the Brazilian banking in the period of 2000– 2007 using the DEA and claims that the efficiency scores are lower than other countries. They analyze the impact of market share and non-performing loans on the efficiency via panel data analysis. They also claim that the foreign banks in Brazil are less cost efficient and the state owned banks are more efficient relatively.

Avkiran (2011) investigates the relationship between a bank's DEA efficiency scores and the performance ratios for the Chinese banks for years 2007 and 2008. Further investigations about how the DEA is utilized to select the ratio benchmarks for firm groups imply that firm based standardization, stock pricing, and regulations are the areas that ratio benchmarking may be utilized to predict the future values of some financial ratios via efficiency estimates.

Pasiouras (2008) utilizes the DEA to explore the efficiency of the Greek banking industry over the period of 2000-2004. The findings suggest that Greek banks with abroad operations have higher TE scores. One can claim that a higher efficiency depends on a greater number of branches, loan activity, market power, and capitalization.

Havranek and Irsova (2013) examine and compare the efficiencies of the banks in the Czech Republic, Hungary, Poland, Slovenia, Slovakia, and the USA for the 1995–2006 period and how the specifications of the DEA change the efficiency. They argue that the foreign banks in the transition economies are more efficient. Another finding is that while the large banks in the USA are definitely performing better, the result for remaining the Central European and the Eastern European countries depends on the design of DEA.

Mercan et al. (2003) present a financial performance index for the Turkish commercial banks to observe the effects of scale and the mode of ownership on a bank's behavior and performance for the 1989-99 period. Their study indicates that the state-owned banks are outperformed by the foreign and the private banks in terms of efficiency and the large scaled banks seem to perform better than the small or medium sized banks. They also state that the banks taken over by the regulatory agency provided poor efficiency scores.

Denizer et al. (2007) examine the banking efficiency in Turkey between 1970 and 1994 via the DEA. Their study suggests that there is a decline in banking efficiency after the liberalization program due to the macroeconomic instability of the Turkish economy, especially in the financial sector.

Fukuyama and Matousek (2011) make a variable returns to scale efficiency analysis of the cost efficiency, the TE and the allocative efficiency of the Turkish banks for the period from 1991 to 2007. They argue that the results reflect the picture of the Turkish economy during the 2001 financial crises from 1994 to 2001. They observe some positive effects of the restructuring the financial system and the consolidation policy implemented after the crisis.

Unvan and Tatlidil (2012) investigate the performance of the Turkish banking industry for the period 2002– 2008 by using the DEA and the Malmquist Index, (MI) for Total Factor Productivity (TFP). They state that the industry faces an efficiency loss from 2005 to 2008 and the medium-sized banks are the most efficient banks.

Isik and Hassan (2003) use the DEA and the MI to examine changes in productivity, efficiency, and technology in the Turkish commercial banks after the 1980s deregulation of the banking industry. The study suggests that the performance gap between the banks is slowly disappearing. They also confirm that the foreign banks, in general, are more efficient than the domestic banks. They also find that the private banks experienced more volatile scores than the public banks.

3. METHODOLOGY

Debreu (1951), Koopmans (1951), and Farrell (1957) are the first ones using efficiency analysis in the economics literature, and since then there have been so many studies devoted to the measurement of efficiency. Using frontier functions is an important part of the measurement of efficiency. The usage of the parametric and non-parametric methods in the studies where the performance assessment is measured in terms of Economic Efficiency, TE, and Allocative Efficiency (AE) also exist.

Parametric approach contains deterministic and stochastic models. In non-parametric analysis as in Charnes et al. (1979), the specification of any particular functional form is not necessary to define the efficient frontier or envelopment surface.

3.1. Structure of DEA and Efficiency

Efficiency might be defined as an achievement to obtain the highest output possible by preferring the method which uses the input composition in the most productive way. By Koopmans's definition (1951), the production limit is defined as $f(x_t,y_t)= 0$, then $(x_t,y_t)<0$ expresses the production limits which is not technically efficient. If $f(x_t,y_t)>0$, then it gives input-output compositions which are not possible to generate by using a certain production technique (Kumbhakar and Lovell, 2000), (Cooper et al. 2006). Assuming that a DMU generates outputs y_i, (i=1,2,…,t) from inputs x_k, (k=1,2,…,m), the equation can be expressed in the following way by the appropriate weights (v_i=1,2,…,t; w_k=1,2,…,m) applied to the variables:

$$\sum_{i=1}^{t} v_i y_i \,/\, \sum_{k=1}^{m} w_k x_k \qquad (1)$$

Fractional program utilizes the TFP rate. In a sense, DEA should be considered as a conceptual model and the linear model is a practical method in efficiency calculations. In DEA, weights are determined pertaining to the DMUs for each input and each output.DEA takes inputs (x_k) and outputs (y_i) into equation as given above and selects weights to maximize performance of DMU "p" related to performances of other units:

$$Max\ v_i w_k \left(\sum_{i=1}^{t} v_i , y_{ip} \,/\, \sum_{k=1}^{m} w_k , x_{kp}\right) \qquad (2)$$

Here, the efficiency values of "z" number of DMUs are given as;

$$0 \le \sum_{i=1}^{t} v_i y_{ic} \,/\, \sum_{k=1}^{m} w_k x_{kc} \le 1 \text{(c=1,2,…,p,…,z;)} \qquad (3)$$

In the model, v_i=1,2,…,t; and w_k =1,2,…,m correspond to the weights of inputs and outputs and variables in the equation. Solution of this model gives an efficiency value of P^{th} DMU and a set of necessary weights to reach that value.

Solution of the non-parametric efficiency measurement model in the form of fractional programming form is converted to a linear programming model which is relatively easier to solve (Charnes et al., 1978, 1979; Banker et al., 1984).

3.2 Panel Regression Analysis

In panel regression estimation, there are two significant approaches; fixed effects approach and random effects approach (Gujarati, (2004); Balgati, (2008)). For the estimations obtained in this study, the appropriate model is the random effects model. This panel model may be formulated as follows.

$$Y_{it} = \beta_{1i} + \beta_2 X_{2it} + \beta_3 X_{3it} + ...\beta_k X_{kit} + u_{it} \qquad (4)$$

In this equation, the variable β_{1i} is a random variable with an average of β_1. For each firm, $\beta_{1i} = \beta_1 + e_i$, (i = 1, 2, ..., 31) is the intercept with e as a random error term with a zero average and a constant variance. The underlying logic behind is that the constant (β_1) is the same for the five investigated outputs and it is considered as a general average. The individual and the subjective constant is expressed within the error term (e_i).

3.3 The Malmquist Index

The Malmquist productivity Index is one of the indices that explore change in production (Malmquist, 1953). Used in the DEA of Caves et al. (1982), this index consists of difference functions representing multi-output and multi-input technologies based on input and output quantities.

The index can be calculated by using parametrical and linear programming methods. Two functions can be obtained by use of DEA. One of these functions expresses the technical change and the other one does change in the TE (Liu and Wang, 2008).

MI can be calculated either input oriented or output oriented. An output oriented Malmquist TFP change index M_h^{t+1} can be expressed as:

$$M_h^{t+1}(X_h^{t+1}, Y_h^{t+1}, X_h^{t}, Y_h^{t}) = \left[\frac{D_h^t(X^{t+1}, Y^{t+1})}{D_h^t(X^t, Y^t)} \frac{D_h^{t+1}(X^{t+1}, Y^{t+1})}{D_h^{t+1}(X^t, Y^t)} \right]^{1/2} \qquad (5)$$

This equation shows production element of D_h in period t and t+1. Taking technology in period of t as reference, period t+1 is used. Reference categories can be selected arbitrarily. Here, in the application related to the

banks, the inputs vector is $x_h^t = (X_{1ht}, X_{2ht}....)'$ and the output vector is $y_h^t = (Y_{1ht}, Y_{2ht}....)'$ with (h=1,2,…..,n).

4. EMPIRICAL FINDINGS

In Turkey, before and after the 2001 financial crisis, a series of banks were closed down or the management of these banks was transferred to the state. Following these negative changes in the banking sector, a series of legal arrangements and some structural changes were made between 2003 and 2012. The activity analysis with seven inputs and five outputs variables of the private domestic banks, the private foreign banks, and the public banks was implemented. This amount of inputs was not included in some other studies. For instance, in the analyses of the Turkish banking sector; Işık and Hassan (2003) utilized 3 input and 4 output variables, Mercan et al. (2003) used 2 input and 3 output variables, and Fukuyama and Matousek (2011) used 2 input and 2 output variables. In this respect, the number of the input and output variables used in this study is one of the essential differences of this study.

Another point is that ten-year TE and AE data were used in this study. Economic efficiency data is not stated here again when it is a multiplication of these two data outputs. After the comparison of the TE and the AE, determining the outputs which have corrective or detractive effects on these scores in the econometric method is investigated.

While determining the efficiency scores by the DEA, the surplus of the inputs and the scarcity of the outputs are determined by using input-oriented or output-oriented models. The TE and the AE are calculated by using an input-oriented CCR model, which is referred to as the constant returns to scale, and an input-oriented BCC model, which is referred to as the variable returns to scale. Thus, the success of the econometric method determining the efficiency scores is observed.

In this study, the CCR model referring to as the constant returns to scale and the BCC model referring to as the variable returns to scale were used to conduct an efficiency analysis and the results are evaluated. The Table 2 below indicates the descriptive statistics of the inputs and the outputs comprising of 230 data for the years from 2003 to 2012. As seen in the table, the net assets variable has the highest values and the deposit variable has the highest standard deviations.

Table 2. Descriptive Statistics

	Deposits	Paid Fees & Commissions	Other Operations Expenses	Interest Expenses	Net Assets	Employee Payments	Number of Employees	Received Fees & Commissions	Other Operational Income	Interest Income	Credits & Lending	Operational Income
	D_t (10^3 TL)	PFC_t (10^3 TL)	OOE_t (10^3 TL)	IE_t (10^3 TL)	NA_t (10^3 TL)	EP_t (10^3 TL)	NE_t	RF_t (10^3 TL)	OOI_t (10^3 TL)	II_t (10^3 TL)	CL_t (10^3 TL)	OI_t (10^3 TL)
Mean	18702235	75666.51	808383.6	1648393.	25378547	468628.9	6453.922	406773.9	189471.6	2867636.	14564021	1822634.
Median	5383741.	23857.50	421856.5	547408.0	7116006.	174974.0	3917.500	140404.0	76464.50	1023517.	4606351.	724946.0
Maximum	1.26E+08	484484.0	4484306.	9265832.	1.61E+08	3042824.	24698.00	2492089.	1569284.	14810669	1.07E+08	9814381.
Minimum	0.000000[7]	123.0000	12297.00	1977.000	100685.0	5539.000	31.00000	178.0000	72.00000	6147.000	3407.000	7103.000
Std. Dev.	26544578	103980.4	922191.3	2142331.	36182789	647457.3	6673.656	554293.8	273969.7	3619745.	21201439	2285100.
Skewness	1.835844	1.716521	1.355067	1.453638	1.860786	2.056589	0.954138	1.726893	2.215921	1.392579	1.995168	1.415212
Kurtosis	5.873940	5.526248	4.315798	4.211071	5.954249	6.863161	2.907148	5.451587	8.270153	3.981325	6.638678	4.062367
Jarque-Bera	208.3495	174.1072	86.97973	95.05660	216.3695	305.1548	34.98049	171.9146	454.4008	83.56763	279.4765	87.59097
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	4.30E+09	17403298	1.86E+08	3.79E+08	5.84E+09	1.08E+08	1484402.	93557998	43578464	6.60E+08	3.35E+09	4.19E+08
SumSq.Dev.	1.61E+17	2.48E+12	1.95E+14	1.05E+15	3.00E+17	9.60E+13	1.02E+10	7.04E+13	1.72E+13	3.00E+15	1.03E+17	1.20E+15
Observation	230	230	230	230	230	230	230	230	230	230	230	230

*The first 7 columns represent input variables (X) and remaining 5 are output variables (Y). t = 03, 04, 05,…,12.

[7] Deutsche Bank was not accepting deposits before 2004 and therefore there is only one zero value fort the variable of deposits.

The TE and AE scores determined by the CCR model for 23 banks are given in Table 3. While only 3 banks did not have TE in 2003, 18 banks did not have AE in the same year. After ten years, the number of the banks without TE increased to 6, and the number of those without AE to 19. Thus, at the end of this period, approximately 26% of the banks, analyzed in the CCR model, did not have TE and 83% did not have AE.

It is observed that some of the banks were not efficient in terms of AE during this term. Among these banks, Turkish Bank and FibaBank did not have AE. Along with this fact, the former had four years and the latter had five years of efficiency. On the other hand, the public banks including Ziraat, Vakıf and Halk Bank did not seem to have AE. Isbank, one of the biggest banks in Turkey; and Türk Ekonomi Bankası (TEB) with lower deposit amount are among the banks with low performance. Considering all these years, 2008 was the most effective year for all the banks. And 2011 and 2012 were the years when the banks had the lowest performance. Considering the efficiency rate, FibaBank had the lowest efficiency ratio in this period. When FibaBank is taken as an example, the AE score was 19% in 2003. Even though the number of the efficient banks decreased, the efficiency scores increased.

Table 4 gives the estimations for the same efficiencies with the BCC model. In 2003, only one bank did not have TE and ten banks did not have AE. After ten years, in 2012, the number of the banks without TE quadrupled, and the banks without AE rose up to sixteen. Thus in 2012, 17% of the banks did not have TE and 67% did not have AE.

The efficiency of the banks was higher in the BCC model and 2008 was the most efficient year for the banks. In this model, it was seen that the small scale banks were less efficient. TurkishBank, FibaBank, T-Bank, BurganBank and TekstilBank were among the banks with the lowest efficiency. The AE score of Turkish Bank in 2003 was only 20%. As in the CCR model, even though the number of the efficient banks decreased in number, the efficiency scores in the BCC model also increased.

Table 3. TE and AE Scores of 23 DMU According to the CCR Method

Company	TE_{03}	AE_{03}	TE_{04}	AE_{04}	TE_{05}	AE_{05}	TE_{06}	$AE3_{06}$	TE_{07}	AE_{07}	TE_{08}	AE_{08}	TE_{09}	AE_{09}	TE_{10}	AE_{10}	TE_{11}	AE_{11}	TE_{12}	AE_{12}
Akbank	1	0.654	1	0.778	1	0.674	1	0.818	1	0.880	1	0.753	1	0.677	1	0.727	1	0.739	1	1
Abank	1	0.814	1	1	1	1	1	1	1	1	1	0.879	1	1	1	1	1	0.830	1	0.834
Anadolubank	1	0.664	1	0.700	0.862	0.795	0.947	0.890	1	0.970	0.995	0.861	0.964	0.846	1	0.867	0.980	0.862	0.937	0.829
A&T Bank	1	1	1	1	1	0.956	1	1	1	1	1	1	1	1	1	1	1	0.656	1	0.663
Burgan Bank	0.924	0.742	1	0.708	1	0.625	1	0.638	1	0.962	1	0.931	1	0.871	1	0.930	1	0.846	0.907	0.811
Citibank	1	1	1	0.889	1	1	1	0.505	1	1	1	0.897	1	1	1	0.933	0.846	0.884	1	1
Denizbank	1	0.655	1	0.752	0.940	0.860	1	0.850	0.986	0.949	1	1	1	1	1	1	1	1	1	0.775
Deutsche Bank	1	1	1	1	1	1	0.974	0.872	1	1	1	1	1	1	1	0.460	1	1	1	1
Fibabanka	0.497	0.192	0.672	0.754	0.905	0.658	1	0.638	1	0.661	1	0.830	1	0.773	0.869	0.845	1	0.889	1	0.853
Finansbank	1	1	1	1	1	1	1	1	1	1	1	0.991	1	0.888	1	0.899	1	0.937	1	0.786
Hsbc	1	1	1	0.972	1	0.931	1	1	1	1	1	1	1	1	1	1	1	1	0.974	0.891
Ing Bank	1	0.972	1	0.967	1	0.836	1	0.771	0.944	0.950	1	0.946	1	1	1	1	1	1	1	1
Şekerbank	1	0.661	1	1	1	1	1	0.960	1	1	1	1	1	0.937	0.993	0.858	1	0.859	1	0.917
Tekstilbank	1	0.895	1	0.970	1	0.917	1	0.925	1	1	1	1	0.989	0.922	1	0.777	0.984	0.782	0.977	0.766
Turkishbank	0.978	0.197	1	0.844	1	0.771	1	0.769	0.821	0.840	1	0.625	0.756	0.596	0.900	0.550	0.739	0.761	0.750	0.661
Tbank	1	0.950	0.897	0.855	0.960	0.751	1	0.798	1	0.953	1	0.861	1	0.757	1	0.830	1	0.707	1	0.778
Teb	1	0.865	1	0.924	0.832	0.870	0.900	0.828	0.952	0.973	0.977	0.983	0.954	0.985	1	1	1	0.941	1	0.786
Ziraat Bankası	1	0.419	1	0.818	1	0.687	1	0.740	1	0.779	1	0.646	1	0.673	1	0.619	1	0.668	1	0.526
Garanti	1	0.739	1	0.927	1	0.785	1	1	1	1	1	0.801	1	0.728	1	0.788	1	0.843	0.999	0.689
Halkbank	1	0.694	1	0.881	1	0.794	1	0.775	1	0.857	1	0.711	1	0.698	1	0.743	1	0.768	1	0.648
Türkiye İş Bankası	1	0.618	1	0.735	1	0.592	1	0.697	1	0.810	1	0.697	1	0.689	1	0.712	1	0.726	1	0.670
Vakıfbank	1	0.616	1	0.738	1	0.699	1	0.789	1	0.849	1	0.785	0.940	0.708	1	0.737	1	0.849	1	0.704
Yapıkredi	1	0.827	1	0.857	0.979	0.728	1	0.854	1	1	1	0.870	1	0.897	1	0.976	1	0.968	1	0.734

Table 4. TE and AE Scores of 23 DMU According to the BCC Method

Company	TE_{03}	AE_{03}	TE_{04}	AE_{04}	TE_{05}	AE_{05}	TE_{06}	$aE3_{06}$	TE_{07}	AE_{07}	TE_{08}	AE_{08}	TE_{09}	AE_{09}	TE_{10}	AE_{10}	TE_{11}	AE_{11}	TE_{12}	AE_{12}
Akbank	1	1	1	1	1	1	1	1	1	0.880	1	1	1	0.968	1	0.973	1	0.907	1	1
Abank	1	0.834	1	1	1	1	1	1	1	1	1	0.901	1	1	1	1	1	0.836	1	0.834
Anadolubank	1	0.668	1	0.696	0.864	0.795	0.864	0.795	1	0.970	1	0.860	1	0.821	1	0.870	0.981	0.861	0.950	0.819
A&T Bank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.662	1	0.678
Burgan Bank	0.952	0.767	0.898	0.781	1	0.647	1	0.647	1	0.962	1	0.936	1	0.875	1	0.935	1	0.849	0.909	0.815
Citibank	1	1	1	1	1	1	1	1	1	1	1	0.989	1	1	1	0.998	1	0.770	1	1
Denizbank	1	0.693	1	0.942	1	0.939	1	0.939	0.986	0.949	1	1	1	1	1	1	1	1	1	0.854
Deutsche Bank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.492	1	1	1	1
Fibabanka	1	0.594	0.656	0.939	0.927	0.714	0.927	0.714	1	0.661	1	0.855	1	0.816	0.895	0.878	1	0.908	1	0.866
Finansbank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.967
Hsbc	1	1	1	1	1	0.984	1	0.984	1	1	1	1	1	1	1	1	1	1	1	0.934
Ing Bank	1	1	1	1	1	0.836	1	0.836	0.944	0.950	1	0.946	1	1	1	1	1	1	1	1
Şekerbank	1	1	1	1	1	1	1	1	1	1	1	1	1	0.938	1	0.853	1	0.882	1	0.999
Tekstilbank	1	0.905	1	0.966	1	0.942	1	0.942	1	1	1	1	0.989	0.942	1	0.793	0.988	0.792	0.988	0.771
Turkishbank	1	0.200	1	0.715	1	0.777	1	0.777	0.821	0.840	1	0.626	0.772	0.606	0.952	0.577	0.749	0.759	0.777	0.689
Tbank	1	1	1	0.887	1	0.792	1	0.792	1	0.953	1	0.890	1	0.796	1	0.830	1	0.728	1	0.790
Teb	1	0.943	1	0.972	0.842	0.860	0.842	0.860	0.952	0.973	1	1	1	1	1	1	1	0.977	1	0.787
Ziraat Bankası	1	1	1	1	1	1	1	1	1	0.779	1	1	1	1	1	1	1	1	1	1
Garanti	1	0.962	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Halkbank	1	1	1	1	1	1	1	1	1	0.857	1	0.969	1	0.966	1	0.991	1	0.955	1	0.677
Türkiye İş Bankası	1	1	1	1	1	1	1	1	1	0.810	1	1	1	1	1	1	1	1	1	1
Vakıfbank	1	0.844	1	1	1	0.939	1	0.939	1	0.849	1	0.985	1	0.916	1	0.981	1	1	1	0.908
Yapıkredi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.931

The panel regression parameters for the TE and the AE scores obtained in the CCR and the BCC models were estimated. In this estimation, the outputs for the efficiency scores are used as independent variables, and the efficiency scores are used as dependent variables. These TE and AE scores are related to the panel regression analysis for each DMU. Four panel regression analyses- two for the efficiencies, two for the models- are implemented. This classification was made regardless of the sign which might be negative or positive. The logarithms of the independent variable models are given as:

$$TE_{CCRt} = \beta_1 + \beta_2 ln\,\mathrm{CL_t} + \beta_3 ln\,\mathrm{OI_t} + \beta_4 ln\,\mathrm{II_t} + \beta_5 ln\,\mathrm{RF_t} + \beta_6 ln\,\mathrm{OOI_t} \quad (6)$$

$$TE_{BCCt} = \beta_1 + \beta_2 ln\,\mathrm{CL_t} + \beta_3 ln\,\mathrm{OI_t} + \beta_4 ln\,\mathrm{II_t} + \beta_5 ln\,\mathrm{RF_t} + \beta_6 ln\,\mathrm{OOI_t} \quad (7)$$

$$AE_{CCRt} = \beta_1 + \beta_2 ln\,\mathrm{CL_t} + \beta_3 ln\,\mathrm{OI_t} + \beta_4 ln\,\mathrm{II_t} + \beta_5 ln\,\mathrm{RF_t} + \beta_6 ln\,\mathrm{OOI_t} \quad (8)$$

$$AE_{BCCt} = \beta_1 + \beta_2 ln\,\mathrm{CL_t} + \beta_3 ln\,\mathrm{OI_t} + \beta_4 ln\,\mathrm{II_t} + \beta_5 ln\,\mathrm{RF_t} + \beta_6 ln\,\mathrm{OOI_t} \quad (9)$$

Each of the scores contains data as the same number as the number of DMUs (number of companies). These regression analyses were estimated one by one with fixed effects and random effects methods. In the estimations, the method of the random-effects panel regression analysis where technical and AE scores are used as dependent variables was found correct according to the Hausman's test.

In Table A1, the estimation of AE score in the CCR (AE_{CCR}) model, credits & lending and the interest income have a negative significant effect on the efficiency whereas the received fees & commissions has a positive significant effect on the efficiency score. In, the regression where the TE_{CCR} score is a dependent variable, the credits & lending has a negative effect on the efficiency and the other operational income and received fees & commissions have a positive effect on the efficiency score, as shown in Table A2.

In Table A3, in the regression where the AE_{BCC} score is a dependent variable, the credits & lending and the interest income have a negative significant relationship with the efficiency whereas the operational income has a positive significant effect on the efficiency. Finally, in Table A4, in the estimation of TE score in the BCC (TE_{BCC}) model of the panel regression analysis, efficiency score has a negative relationship with the credits & lending and a positive relationship with the other operational income.

Considering the four panel regression estimations results above, all the bank credits were found to have a negative and a significant relationship on the efficiency scores in all the estimation models. Besides, when the TE score is taken as a dependent variable, the other operational income has a significant and a positive relationship on the efficiency. Kabasakal et al.

(2012) obtained a set of fewer numbers of meaningful estimators. It can also be said that credits & landing has a negative effect on the efficiency. On the other hand, other operational income has increased the efficiency of the banks. Expanding banks' service areas in usual bank activities other than credits is found to be a factor increasing efficiency. It is interesting that none of the other independent variables have a significant effect on the efficiency of the banks.

4.1. Total Factor Productivity Analysis with Malmquist Index

Productivity scores and parameter estimations of the companies are obtained separately in terms of TFP Analysis with an output-oriented MI. In this analysis, values for TFP Change (tfpch), Technical Change (techch), Efficiency Change (effch), Pure Efficiency Change (pech), and Scale Change (sech) for these companies were estimated. The Figure 1 shows the progresses and the fluctuations of the efficiency changes. The variables techch and tfpch has similar behaviors and their fluctuations are higher compared to those of the other variables.

Figure 1. Fluctuations in Efficiency Scores

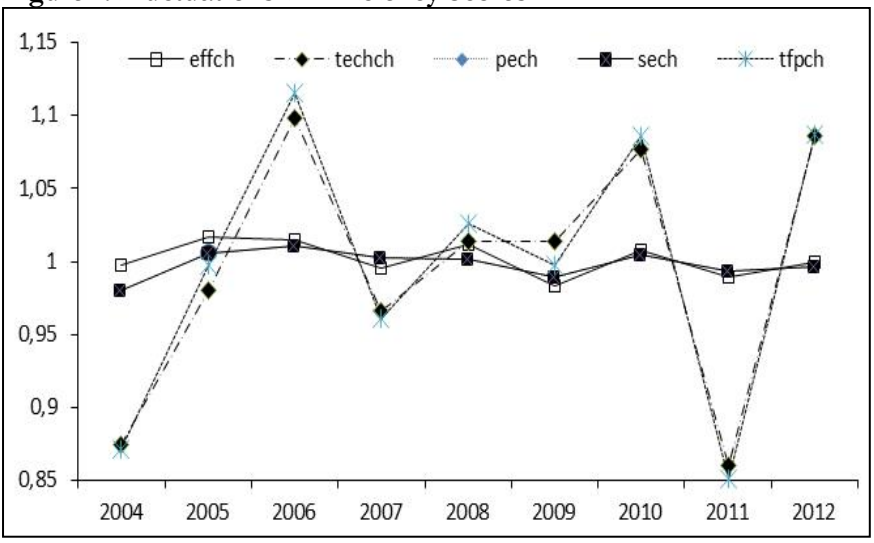

Table 5 below shows the results of the constant returns and input-oriented TFP model by using the MI. In the beginning, the TFP for five years, mainly the first two years, 2004 and 2005, is below one. The lowest productivity is in 2011 with a decrease of 15%. The highest productivity is in 2006 with an increase of 11.5%. When the mean values are considered, as the mean of the period, the TE change, the pure efficiency change and the change in the TFP are below one. That is to say, the productivity change in

the period shows a decreasing trend. The TFP exhibits a decrease at the rate of 0.5% implying that banks did not incur much loss.

Table 1. Malmquist Index: Annual Average Efficiency

Year	effch	techch	pech	sech	tfpch
2004	0.997	0.874	0.980	0.980	0.871
2005	1.017	0.980	1.006	1.006	0.997
2006	1.015	1.098	1.011	1.011	1.115
2007	0.995	0.966	1.003	1.003	0.961
2008	1.012	1.014	1.002	1.002	1.026
2009	0.983	1.014	0.989	0.989	0.997
2010	1.008	1.077	1.005	1.005	1.086
2011	0.989	0.860	0.993	0.993	0.851
2012	1.000	1.086	0.996	0.996	1.087
Mean	1.002	0.993	0.998	1.004	0.995

The Table 6 below shows the TFP and the other efficiency changes of the banks within the given time in the MI. When the efficiency during the entire period for all the companies is considered, it can be seen that pech value decreases at the rate of 0.2%, whereas techch value does not change at all, and that effch and tfpch values increase at the rate of 0.2%, and sech value increases at the rate of 0.4%. There are 5 companies with a TFP is below one. Considering the means of the efficiency for all the business enterprises, all the others except one with a pure efficiency change are observed to increase at the level of thousandths.

5. CONCLUSION

In this study, the TE and the AE scores of 23 efficient commercial banks in Turkey are obtained from two models using the DEA in a ten-year-period covering the years from 2003 to 2012.

In the TE Analysis by the CCR model only 3 banks were not efficient for the first year; however, this number increased to 6 at the end of that period. In the AE Analysis, only 5 banks were efficient in the first year and this number decreased to 4 in the last year. The AE was pretty low and this inefficiency continued for ten years. At the end of ten years, the number of the banks without TE increased to 6; and the number of the banks without AE increased to 19. Thus, in the analysis of the CCR model at that period, approximately 9-26% of the banks did not have TE, and 70-83% of the banks did not have AE. It is observed that 2 banks were never efficient in terms of AE; however, the same two banks had TE for only 4 times. Overall, all the banks had their highest TE scores in 2008 and the lowest scores in the years 2011 and 2012.

Table 2. Malmquist Index: Firms' Average Efficiency

Company	effch	techch	pech	sech	tfpch
Akbank	1.000	1.022	1.000	1.000	1.022
Abank	1.000	1.010	1.000	1.000	1.010
Anadolubank	0.993	1.057	0.994	0.999	1.049
A&T Bank	1.000	0.984	1.000	1.000	0.984
Burgan Bank	0.998	1.005	0.995	1.003	1.003
Citibank	1.000	1.030	1.000	1.000	1.030
Denizbank	1.000	1.031	1.000	1.000	1.031
Deutsche Bank	1.000	0.555	1.000	1.000	0.555
Fibabanka	1.081	1.064	1.000	1.081	1.150
Finansbank	1.000	1.004	1.000	1.000	1.004
Hsbc	0.997	0.999	1.000	0.997	0.996
Ing Bank	1.000	1.061	1.000	1.000	1.061
Şekerbank	1.000	0.993	1.000	1.000	0.993
Tekstilbank	0.997	1.075	0.999	0.999	1.072
Turkishbank	0.971	1.073	0.972	0.999	1.042
Tbank	1.000	1.067	1.000	1.000	1.067
Teb	1.004	1.005	1.000	1.004	1.010
Ziraat Bankası	1.000	0.977	1.000	1.000	0.977
Garanti	1.000	1.014	1.000	1.000	1.014
Halkbank	1.000	0.984	1.000	1.000	0.984
Türkiye Iş Bankası	1.006	1.013	1.000	1.006	1.020
Vakıfbank	1.001	1.045	1.000	1.001	1.046
Yapıkredi	1.000	1.013	1.000	1.000	1.013
Mean	1.002	1.000	0.998	1.004	1.002

In the analysis of the BCC model, while the number of the banks without TE at the beginning of the period was one, it rose up to 4 at the end. The number of the banks which had AE was 13 and it decreased to 7 at the end. Thus in 2012, 17% of the banks did not have TE, and 69% did not have AE and 2008 was the year when all the banks had TE. The small scale banks were less efficient in this model. Even though the efficiency of banks decreased in number, similar to the CCR model, efficiency score increased in BCC model as well.

Taking the AE_{CCR} as a dependent variable in the regression, credits & lending and interest income in the estimation carried out with the AE score in the CCR model are found to be negative and significant on the efficiency, and the received fees & commissions have a positive and a significant relationship with the efficiency. In the regression when the TE_{CCR} score is a dependent variable, the credits & lending have a negative effect on the efficiency score and other operational income and received fees & commissions have a positive effect.

The results related to the constant returns and the input-oriented TFP were found by using the MI. In the beginning, the TFP in the terms of five years, for the first two years, 2004 and 2005, it is below one. The lowest

productivity is observed in 2011 with a decrease at the rate of 15%. The highest productivity is seen in 2006 with an increase at the rate of 11.5%. When the mean values are considered, as the mean of the period, the TE change, the pure efficiency change and the change in the TFP are below one. It can be said that the productivity change in the period shows a decreasing trend. The TFP exhibited a decrease only at the rate of 0.5%. Considering this number, it can be claimed that during the investigated period of time, banks did not incur much loss.

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APPENDICES

Table A 1. Panel Regression Estimators of AE with CCR Model

Dependent Variable: AE_{CCAEt} CCRAE; Sample: 2003 2012; Method: Panel EGLS (Cross-section random effects)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LnCL	-0.014561	0.005940	-2.451578	0.0150*
LnRF	0.048093	0.014123	3.405307	0.0008**
LnII	-0.074359	0.025284	-2.940906	0.0036**
LnOI	0.014556	0.031142	0.467409	0.6406
LnOOI	0.018432	0.011273	1.635114	0.1034
C	1.026307	0.049255	20.83659	0.0000
	Effects Specification			
			S.D.	Rho
Cross-section random			0.042173	0.0919
Idiosyncratic random			0.132544	0.9081
	Weighted Statistics			
R-squared	0.116609	Mean dependent var		0.597779
Adjusted R-squared	0.097733	S.D. dependent var		0.140221
S.E. of regression	0.133192	Sum squared resid		4.151213
F-statistic	6.177657	Durbin-Watson stat		1.821331
Prob(F-statistic)	0.000021			
	Unweighted Statistics			
R-squared	0.102067	Mean dependent var		0.848004
Sum squared resid	4.596142	Durbin-Watson stat		1.645017
Correlated Random Effects - Hausman Test				
Test cross-section random effects				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		7.294286	5	0.1997
(**) P≤0.01 , (*) P≤0.05				

Table A 2. Panel Regression Estimators of TE with CCR Model

Dependent Variable: TE_{CCRt} CCRTE; Sample: 2003 2012; Method: Panel EGLS (Cross-section random effects)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LnCL	-0.009287	0.002206	-4.209461	0.0000**
LnRF	0.013910	0.005357	2.596738	0.0100**
LnII	0.004985	0.009370	0.532015	0.5952
LnOI	-0.016265	0.011563	-1.406692	0.1608
LnOOI	0.015144	0.004230	3.579956	0.0004**
C	1.066418	0.018275	58.35335	0.0000
	Effects Specification			
			S.D.	Rho
Cross-section random			0.000000	0.0000
Idiosyncratic random			0.051487	1.0000
	Weighted Statistics			
R-squared	0.164416	Mean dependent var		0.985000
Adjusted R-squared	0.146562	S.D. dependent var		0.054112
S.E. of regression	0.049989	Sum squared resid		0.584748
F-statistic	9.208742	Durbin-Watson stat		1.924663
Prob(F-statistic)	0.000000			
	Unweighted Statistics			
R-squared	0.164416	Mean dependent var		0.985000
Sum squared resid	0.584748	Durbin-Watson stat		1.924663
Correlated Random Effects - Hausman Test				
Test cross-section random effects				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		1.067286	5	0.9570
(**) P≤0.01 , (*) P≤0.05				

Table A 3. Panel Regression Estimators of AE with BCC Model

Dependent Variable:AE_{BCCAEt}; BCCAE Sample: 2003 2012; Method: Panel EGLS (Cross-section random effects)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LnCL	-0.022972	0.004259	-5.393372	0.0000**
LnRF	0.015657	0.010342	1.513895	0.1314
LnII	-0.038304	0.018089	-2.117482	0.0353*
LnOI	0.062864	0.022323	2.816107	0.0053**
LnOOI	0.013427	0.008167	1.644080	0.1015
C	1.058955	0.035282	30.01377	0.0000
Effects Specification				
			S.D.	Rho
Cross-section random			0.000000	0.0000
Idiosyncratic random			0.099402	1.0000
Weighted Statistics				
R-squared	0.280125	Mean dependent var		0.925700
Adjusted R-squared	0.264743	S.D. dependent var		0.116727
S.E. of regression	0.100090	Sum squared resid		2.344221
F-statistic	18.21130	Durbin-Watson stat		2.200632
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.280125	Mean dependent var		0.925700
Sum squared resid	2.344221	Durbin-Watson stat		2.200632
Correlated Random Effects - Hausman Test				
Test cross-section random effects				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		8.323894	5	0.1393
(**) P≤0.01 , (*) P≤0.05				

Table A 4. Panel Regression Estimators of TE with BCC Model

Dependent Variable: TE_{BCCTEt}; BCCTE Sample: 2003 2012; Method: Panel EGLS (Cross-section random effects)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LnCL	-0.006689	0.001742	-3.839029	0.0002**
LnRF	0.005499	0.004231	1.299818	0.1949
LnII	-0.005176	0.007400	-0.699425	0.4850
LnOI	0.002584	0.009132	0.283012	0.7774
LnOOI	0.010417	0.003341	3.118135	0.0020**
C	1.042215	0.014433	72.20847	0.0000
	Effects Specification			
			S.D.	Rho
Cross-section random			0.000000	0.0000
Idiosyncratic random			0.040664	1.0000
	Weighted Statistics			
R-squared	0.138597	Mean dependent var		0.989271
Adjusted R-squared	0.120190	S.D. dependent var		0.042331
S.E. of regression	0.039706	Sum squared resid		0.368909
F-statistic	7.529942	Durbin-Watson stat		2.104847
Prob(F-statistic)	0.000001			
	Unweighted Statistics			
R-squared	0.138597	Mean dependent var		0.989271
Sum squared resid	0.368909	Durbin-Watson stat		2.104847
Correlated Random Effects - Hausman Test				
Test cross-section random effects				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		2.938215	5	0.7095
(**) P≤0.01 , (*) P≤0.05				