Study of privatization effects on resources productivity by productivity by using data envelopment model and MalmQuist index: A case study for branches of Kermanshah province Mellat Bank

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ABSTRACT

Economic effects of human beings have been always focused on how to obtain the best results b using the least possibilities and factors available, such tendency can be called "attainment of higher efficiency and productivity". Productivity is a comprehensive concept encompassing efficiency an increase in which is taken into account by politic and economic authorities continuously in order to promote standard of living of, welfare of, and relaxation and peace of people. Some consider survival and persistence of a politico-economic system dependent on productivity. One way to increase productivity is privatization and free trade. Present research focuses on effects of these 2 variables on each other. Subject of this research is to study effects of privatization on total productivity of production factors in in Mellat Bank and its aim is to analyze productivity after Mellat Bank was privatized in order for resulting outcomes to create clearer outlook and wider perspective in front of managers. Considering research aim and subject, this research used descriptive-analytical method. In present research, inputs and outputs of 48 Mellat Bank of Kermanshah province were studied in 2 time intervals: one related to pre-privatization time (2005-2007) and other to post-privatization time (2009-2011) of Mellat Bank. This research inputs include personnel, administrative, and operational costs while outputs include volumes of deposits, facilities, and services provided. Data was analyzed by using MalmQuist index and data coverage analysis with EMS and GAMS software. Then, hypotheses were tested by SPSS software. Research results indicate that, following privatization, total productivity index and human force productivity increased significantly and it was found that technological changes relate directly to the level of productivity so that enhanced technology level can increase productivity level.

Introduction

Given limitedness of resources and unlimitedness of human needs, population growth, and severe and ruthless competition in economic world, improvement of productivity is not a choice, but a necessity.

To make efforts to provide individuals and society with better life and welfare.

It is essential to follow productivity growth continuously in order to reach better future. In today' s competitive world, those countries will win which are able to create productive knowledge, insight, and behavior among their managers and employees: some insight creating thinking, reflection, creation, innovation, and creativity within organizations. Given the presence of numerous problems facing Iranian economy at the onset of 3rd A.C. millennium (including high population growth rate, single-product economy, inappropriate structure of economic and administrative system, increased unemployment rate, low investment. etc). The importance of paying attention to productivity, privatization, and promulgation of productivity culture becomes clearer than before. Analysis performed in present research studies effects of privatization on productivity, expressing data quantitatively. Following are other researches in relation to productivity and method of data envelopment analysis done by some individuals inside and outside our country:

-In 1998, Borhani studied allocation efficiency of 32 national commercial Banks during 1993-1995. Reporting average allocation efficiency of 73% for mentioned banks.

- In another research done in 1999, Alizadeh Sane evaluated efficiency of 119 Saderat Bank branches in Tehran province by applying assumptions of fixed returns relative to scale. Results of that research showed that efficiency average was .74 and .89 for fixed and variable returns, respectively.

- In 2001, Amiri defined and calculated measure of efficiency in commercial banks. His objective was to identity shortcomings of pre-planning in banking system by using efficiency index. Based on that study, a positive relationship between banking system efficiency and its structure, inappropriate monitoring. and major weaknesses in monitoring system of banking network as well as a positive relationship between executive power and efficiency of banking system were confirmed .

In a research titled "Determination of relative efficiency of European higher education institutions" done in 2004, Osman Jamadi and Katherine Race estimated efficiency of 209 higher education institutions in Europeans countries in the school year leading to 2004 by using data envelopment analysis(DEA) and assessed factors influencing efficiency by using Toubitt' s model. Some inputs and outputs of that research can be pointed to as follows:

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a)Data : new comer students characteristics (including quality and grades of students)and educational provisions(including professors characteristics, educational materials and aid, technical equipment, libraries conditions , etc)

b) outputs : level of professional skills acquired by students (including theoretical Knowledge and level of awareness of methods) , level of general skills acquired by students (including level of lessons learnt, ability to think, to give opinions, and to recognize in work, ability to solve problems related to merits analysis, level of knowings and reflections).

Difference between general / professional skills acquired by graduates and needs of job market:

Results of research indicate that universities and higher education institutions in England, the Matherland , and Austria possess the highest level of relative efficiency; and Finn, Spanish , and Italian universities exhibit the lowest level of relative efficiency.

An article titled "Estimation of relative efficiency of higher education institutions based on data envelopment analysis method was prepared by Joseph Kallhon from Georgia University, who studied 1323 American higher education institutions in the school year of 1995-96. In that reach, initially , a list of default inputs and outputs was prepared; and in order to determine final inputs / outputs , regression method and its coefficient test equal to the number of default outputs were used , that is , each of default outputs was used as dependent variable and each of default inputs was used as independent one. Final inputs and output were determined by increasing / decreasing outputs and by performing econometric tests.

Hypotheses

Major hypothesis:

1. There is a significant difference between pre- and post-privatization productivity rates .

Minor hypotheses:

1. A direct relationship exists between productivity rate and technological changes before and after privatization.

2. A significant difference exists between pre- and post-privatization rates of human force productivity ration. Research method selection of inputs and outputs.

Inputs		Outputs
1. Administrative costs	Mellat Bank	1. Deposit volume
2. Personnel costs		2. Facilities volume
3. Operational costs		3. Provided services volume
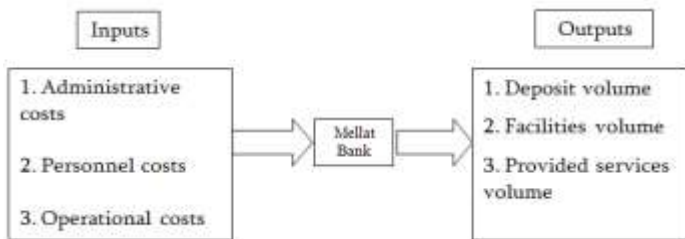
Calculation method

In this research, total productivity changes have been introduced on the basis of MalmQuist Index, which is defined, in tuyn, by using distance functions.

There exist many techniques to measure distance functions, the best-known of which is a linear planning called data envelopment analysis (DEA). In this model, by using DEA method, 4 distance functions are calculated for any enterprise at any time; and to do this, 4 linear planning problems need to be solved. Under technological conditions with constant returns to scale, these 4 problems are as follows:

So that*

$$[d_0^t (Y_t X_t)]^{-1} = \max \phi$$

$$-\phi Y_{it} + Y_t \lambda \geq 0$$

$$X_{it} + X_t \lambda \geq 0$$

$$\lambda \geq 0$$

**So that

$$[d_0^S (Y_S X_S)]^{-1} = \max \phi$$

$$-\phi Y_{iS} + Y_S \lambda \geq 0$$

$$X_{iS} + X_S \lambda \geq 0$$

$$\lambda \geq 0$$

*** $$[d_0^t (Y_S X_S)]^{-1} = \max \phi$$

$$-\phi Y_{iS} + Y_S \lambda \geq 0$$

$$X_{iS} + X_t \lambda \geq 0$$

$$\lambda \geq 0$$

**** $$[d_0^S (Y_t X_t)]^{-1} = \max \phi$$

$$-\phi Y_{it} + Y_S \lambda \geq 0$$

Using distance functions, MalmQuist index is expressed as.

$$M_i^{t+1}(Y^S, X^S, Y^t, X^t) = \left(\frac{d_0^s (Y^t, X^t)}{d_0^s (Y^S, X^S)} \times \frac{d_0^t (Y^t, X^t)}{d_0^t (Y^S, X^S)} \right)^{1/2}$$

Where d_0^s (Y^t , x^t) indicatos time intervals of observations s through t . If $m_0 > 1$, then it shows positive groeth of total productivity of factors during time s to t Æ and if $m_0 < 1$, then it indicates declining trend of total factors productivity .

Above function can be represented by performing some simple mathematical operations :

Total Factors Productivity Changes (TFPCH)	Scale Efficiency Changes (SECH)	Management Efficiency Changes (PECH)	Technical Changes (TCH)	Technical Efficiency Changes (EFCH)	DMU
1/982	1/2491	1/1282	0/8133	1/3502	1
1/969	1/5611	1/1369	1/2054	0/9099	2
0/9174	0/8163	0/9274	0/7687	1/1933	3
1/1907	0/8980	1/2007	0/9287	1/2821	4
1/381	1/973	1/781	1/3759	0/7544	5
1/2285	0/9637	1/2385	1/28	1/225	6
0/9571	0/8331	0/9771	0/6472	1/4788	7
1/1550	0/9432	1/185	1/1024	1/476	8
1/137	0/9124	1/237	0/9873	1/267	9
0/9567	1/1759	0/9867	1/6692	0/5731	10
0/6938	0/6895	0/7138	0/9726	1/314	11
1/2323	1/3404	1/2723	1/3896	0/8868	12
0/7742	0/9786	0/7842	1/90	0/7672	13
0/8478	0/8445	0/8678	0/8398	1/95	14
1/1790	0/8209	1/2190	1/1319	1/416	15
0/9943	0/8235	1/243	1/3701	0/7257	16
0/8858	1/3447	0/9058	0/8322	1/643	17
1/1228	1/1029	1/1628	1/3132	0/855	18
1/3654	1/3367	1/3754	1/3008	1/495	19
0/9731	1/2340	0/9931	0/9849	0/9879	20
1/1206	1/3319	1/1606	1/5485	0/7236	21
1/2375	1/7315	1/2775	1/2462	0/9930	22
1/260	0/7825	1/560	0/8173	1/2552	23
0/9427	0/8201	0/9727	1/3535	0/6964	24
1/822	0/9789	1/1322	1/4759	0/7331	25
1/265	1/1968	1/465	2/3213	0/4422	26
0/8159	0/8084	0/8559	1/1452	0/7124	27
1/1751	0/8777	1/2051	1/935	1/746	28
1	1/1865	1/3	1/1676	0/8564	29
1/2936	1/9614	1/3036	1/2212	1/592	30
0/9222	0/9306	0/9322	0/8405	1/971	31
1/794	1/2323	1/1294	0/9275	1/1636	32
1/2246	1/1304	1/2446	1/7491	0/7001	33
0/9878	1/1957	1/278	0/7916	1/2476	34
0/9024	0/8820	0/9324	0/8231	1/963	35
1/470	1/600	1/970	1/3334	0/7851	36
1/1453	1/2783	1/1653	1/881	1/524	37
1/1957	0/7764	1/2257	1/2281	0/9735	38
0/8025	1/3913	0/8425	0/7245	1/1075	39
1/1731	1/968	1/1931	1/3975	0/8394	40
0/8069	0/9311	0/8569	0/6695	1/2051	41
1/1835	1/7305	1/2235	1/8007	0/6572	42
0/8629	0/7086	0/8929	0/7802	1/1060	43
1/573	0/9592	1/673	0/9287	1/1385	44
0/8745	0/7367	0/8945	0/9915	0/8816	45
0/8370	0/8012	0/8470	0/8443	0/9913	46
1/268	1/2356	1/668	0/9046	1/1350	47
0/9845	0/9150	0/9945	1/1999	0/8205	48

Results obtained prior to privatization

Total Factors Productivity Changes (TFPCH)	Scale Efficiency Changes (SECH)	Management Efficiency Changes (PECH)	Technical Changes (TCH)	Technical Efficiency Changes (EFCH)	DMU
1/1697	1/1204	1/2097	0/9917	1/1794	1
1/3570	1/5420	1/3870	1/3833	0/9809	2
1/450	1/183	1/550	0/7859	1/3296	3
0/9473	0/8474	0/9573	0/6546	1/4471	4
0/7909	1/426	0/8309	0/8794	0/8993	5
1/530	1/480	1/930	0/7778	1/3536	6
1/4380	1/2597	1/4580	0/9025	1/5934	7
1/2190	1/3206	1/2290	0/9326	1/3070	8

1/346	1/919	1/746	1/689	0/9678	9
1/118	1/2081	1/718	1/5336	0/6597	10
1/889	0/9294	1/1189	0/9688	1/1239	11
1/1156	1/2182	1/1356	1/1651	0/9574	12
0/8757	0/9496	0/8957	0/9719	0/8709	13
1/599	1/916	1/699	1/908	1/904	14
1/2171	1/1202	1/671	1/640	1/1439	15
0/8898	0/9627	0/9398	1/54	0/8156	16
1/3438	1/2612	1/3838	1/1509	1/1675	17
1/53	1/721	1/553	1/879	0/9240	18
1/2463	1/2229	1/2763	1/721	1/1623	19
1/3213	1/2675	1/3313	1/2404	1/652	20
0/7590	1/728	0/7990	0/8197	0/9258	21
1/378	1/4318	1/878	0/9322	1/1132	22
1/3480	1/2009	1/3780	1/845	1/2428	23
0/8131	0/8705	0/8431	0/9973	0/8152	24
0/8583	0/9581	0/8883	0/8414	1/199	25
0/9951	1/2408	1/251	1/8828	0/5284	26
0/8368	0/9166	0/8668	0/9604	0/8712	27
1/4161	1/3107	1/4261	1/1917	1/1882	28
0/9532	1/221	0/9932	0/9862	0/9665	29
1/5892	1/6769	1/6292	1/3344	1/1909	30
1/3189	1/1500	1/3589	1/782	1/2232	31
1/2317	1/2974	1/2417	1/3493	1/2553	32
1/883	1/2462	1/1183	0/9811	0/8065	33
1/1557	1/1571	1/1857	0/8393	1/3769	34
1/817	0/9574	1/1117	0/8382	1/2042	35
0/8227	1/1032	0/8327	0/9448	0/8707	36
1/2797	1/2566	1/2997	1/1176	1/1450	37
0/9130	0/9382	0/9230	0/8753	1/431	38
1/4835	1/3192	1/4935	1/2227	1/2132	39
1/26	1/738	1/326	1/579	0/9476	40
1/1054	1/847	1/1554	0/8494	1/3012	41
1/2873	1/5263	1/3273	1/7908	0/7188	42
1/1601	1/886	1/2101	0/9801	1/1836	43
1/1691	1/2227	1/1791	0/9361	1/2488	44
0/8913	0/9309	0/9113	0/8579	1/150	45
0/9457	0/9756	0/9757	0/8781	1/1023	46
1/2506	1/1459	1/2906	1/1333	1/1034	47
1/50	1/1136	1/550	0/9734	1/325	48

Source: Research Findings

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Before	1.0324	48	.15175	.02190
After	1.1048	48	.19887	.02871

Paired Samples Test

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 Before – After	-.07239	.22962	.03314	-.13906	-.00571	-2.184	47	.034

$$M_i^{t+1}(Y^t,X^t,Y^s,X^s)= \frac{d_0^t(Y^t,X^t)}{d_0^s(Y^t,X^t)}\left(\frac{d_0^s(Y^t,X^t)}{d_0^t(Y^t,X^t)} \times \frac{d_0^s(Y^s,X^s)}{d_0^t(Y^s,X^s)}\right)^{1/2}$$

Where

M is MalmQuist index , and the fraction outside the paranthesis measures efficiency changes at himes S and t, that is , efficiency changes indicate the ratio of time+t to time+s efficiency. In above equation , the term inside the paranthesis measures technological changes and equals yeometrical mean of technological changes during 2 periods of time s.t. Therefore , 2 elements of abave equation are :

Efficiency changes = $\dfrac{d_0^t(Y^t,X^t)}{d_0^s(Y^t,X^t)}$

Technological changes = $\left(\dfrac{d_0^s(Y^t,X^t)}{d_0^t(Y^t,X^t)} \times \dfrac{d_0^s(Y^s,X^s)}{d_0^t(Y^s,X^s)}\right)^{1/2}$

Total factors productivity changes = $\text{TCH} + \text{EFCH}$

The first and second fractions inside paranthesis indicate time-t and time-s technologies , respectively , being represented as their geometrical means .

Above analysis is carried out by assuming constant returns to scale while under variable returns to scale conditions , analytical results for technical efficiency are divided into 2 components : scale efficiency and managmant efficiency (Malmqist,1995).

$$M_i^{t+1}(Y^{t+1},X^{t+1},Y^t,X^t)\left[\frac{D_i^t(Y^{t+1},X^{t+1})D_i^{t+1}(Y^{t+1},X^{t+1})}{D_i^t(Y^t,X^t)D_i^{t+1}(Y^t,X^t)}\right]^{1/2}$$

$$\left[\frac{D_0^{t+1}(Y^t,X^t)D_i^{t+1}(Y^{t+1},X^{t+1})}{D_i^t(Y^t,X^t)D_i^{t+1}(Y^t,X^t)}\right]^{1/2}=E_i^{t+1}\times T_i^{t+1}$$

$$\frac{D_i^{t+1}(Y^{t+1},X^{t+1})}{D_i^t(Y^t,X^t)}\times\left[\frac{D_i^t(Y^{t+1},X^{t+1})D_i^t(Y^t,X^t)}{D_0^{t+1}(Y^{t+1},X^{t+1})D_i^{t+1}(Y^t,X^t)}\right]^{1/2}=$$

$$\frac{D_0^t(Y^t,X^t)}{D_0^{t+1}(Y^{t+1},X^{t+1})}\times\left[\frac{D_0^{t+1}(Y^{t+1},X^{t+1})D_0^{t+1}(Y^t,X^t)}{D_0^t(Y^{t+1},X^{t+1})D_0^t(Y^t,X^t)}\right]^{1/2}$$

$$EFCH = SECH \times PECH = \frac{D_i^{t+1}(Y^{t+1},X^{t+1})}{D_i^t(Y^t,X^t)}$$

$$TECHCH=\left[\frac{D_i^t(Y^{t+1},X^{t+1})D_i^t(Y^t,X^t)}{D_i^{t+1}(Y^{t+1},X^{t+1})D_i^{t+1}(Y^t,X^t)}\right]^{1/2}$$

$$SECH = \frac{D_{i,c}^{t+1}(Y^{t+1},X^{t+1})\big/D_{i,y}^{t+1}(Y^{t+1},X^{t+1})}{D_{i,c}^t(Y^t,X^t)\big/D_{i,y}^t(Y^t,X^t)}, PECH=\frac{D_{i,y}^{t+1}(Y^{t+1},X^{t+1})}{D_{i,y}^t(Y^t,X^t)}$$

Where

M indicates MalmQuist index ; X^t and X^{t+1} are inputs in t and t+1 ,respectively ; and Y^t and Y^{t+1} are outputs in t and t+1 , respectively . Extracted data was analyzed by using above

technique and EMS and GAMS software, the results of which are given in tables 7 (pre-privatization) and 8 (post-privatization).

In order to adapt results obtained for 2 time periods, each of obtained components was drawn on one diagram simultaneously, as shown by diagrams 1-4.

Conclusion

Major Hypothesis : There is a significant difference between retes of pre- and post-privatization productivity .

In order to support (reject) this hypothesis, data was examined by using SPSS software.

This test was performed at significance level of 95%, the results of which are as follows:

Since the significance of the test is .34, that is , a significant difference exist between 2 sample , our significant difference exists between 2 samples , our hypothesis is supported . Also given the negativity of lower and upper limits of confidence level, we have seen some growth in total productivity after privatization.

Minor hypotheses

1. There exists a divert relationship between productivity rate and technological changes before and after privatization.

In order to support (reject) this hypothesis, data was studied and tested by using Pearson Correlation Coefficients; and results were extracted by using SPSS software.

Correlations

	Technological changes	Total productivity
Pearson Technological changes Correlation Sig.(2-tailed) N	1 48	.480[**] .1 48
Pearson Total Productivity Correlation Sig.(2-tailed) N	.480[**] .1 48	1 48

** Correlation is significant at the level of 0.01 (2-tailed)

Since the significance of the test is less than .5, therefore, there is a significant correlation between technology and total productivity. Although this correlation is low before privatization, it is direct, positive, and of a coefficient of .48.

Correlations

	Technological changes	Total productivity
Pearson Tevhnological changes Correlation Sig.(2-tailed) N	1 48	.401[**] .5 48
Pearson Total Productivity Correlation Sig.(2-tailed) N	.401[**] .5 48	1 48

** Correlation is significant at the level of 0.01 (2-tailed)

Since the test significance is less than .5, there exists a significant correlation between technology and total productivity. Although this correlation is low after privatization, it is direct, positive, and of a coefficient .401. Therefore, the first minor hypothesis of ours is supported.

2. There exists a significant difference between pre- and post-privatization rates of human force productivity index ratio.

Like the first hypothesis, in order to support / reject this hypothesis, data was studied by using Paired Samples test; And results were extracted by using SPSS software.

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Before	1.0548	48	.15266	.02204
After	1.1339	48	.19822	.02861

Paired Samples Test

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 Before - After	-.07914	.23058	.03328	-.14610	-.01219	-2.378	47	.022

This test was performed at significance level of 95% , with following results :

Since the test significance is .22, a significant difference exists between 2 samples, therefore our hypothesis is supported. Also given the negativity of lower and upper limits of confidence level. We have observed some growth in human force productivity after privatization.

Research recommendations to Banks

1. All banks including Mellat Bank are active under controlled economic conditions, enjoying no discretion necessary to exercise management on their resources.

In order to make maximum economic profit, therefore, banks need to pursue decreasing costs of each production unit. One way to do this is to merge inefficient branches in order for banks to decrease administrative and personnel costs.

2. To locate branches correctly and to move low-efficiency ones to places with more diversity of customers so that they can attract much more deposits while making optimal use of their human force.

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