

# The productive analysis for the Moldavian industry

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**Abstract:** In this paper we present an productive economical analysis of the leading branches of Moldavian industry. We constructed the econometric approach of production frontiers, using the DEA technique (Data envelopment analyses), based on the mathematical programming approach and calculated the Malmquist productive indexes for the selected branches using the certain economical registered data. The data were structured according to the chosen inputs and outputs and performed using the Efficiency Measurement System Program (EMS). The obtained productive indexes leded at a new economical conclusions.

**Key words:** efficiency measurement, Malmquist productivity index, technical change, efficiency change.

## 1 Introduction

The economic of Republic is characterized by the accomplishing of some great reforms to establish the market economy. In this period it can be noticed disappearances or dramatically jumps in the development of any economical branches that identify achievements in reorganization and productivity reorientation. This is why the efficiency and productive analysis is very important to provide to elaborate the correctly economic strategy.

## 2. Technique for productive measurement.

The technical efficiency scores of the economical unit can be calculated using the programming approach DEA technique categorized according to the type of data available. The economic efficiency and productivity can be decomposed into its technical and allocative components, just as in the econometric approach.

### 2.1 The Malmquist Productivity Index Decomposition.

The Malmquist productivity index can be used to construct indexes of output quantity, input quantity or productivity, as ratios of output or input distance functions [2].

This input (output) distance functions are reciprocals of the Debreu-Farrell input (output)-oriented measures of technical efficiency.

Let  $x^t = (x_1^t, \dots, x_N^t) \in R_+^N$  and  $y^t = (y_1^t, \dots, y_M^t) \in R_+^M$  denote respectively an input vector and an output vector in period t, t=1,...,T, where T means the time during the practic estimations.

The output oriented Malmquist productivity index can be defined using three different approaches for the same orientation. It can be decomposed into an index of technical change and an index of technical efficiency change. For the Malmquist index we obtain:

Forward- looking approach:

$$M_0^{t+1}(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)} \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} = \Delta T(x^t, y^t) \Delta TE(x^t, y^t, x^{t+1}, y^{t+1});$$

Backward-looking approach is the following:

$$M_0^t(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} = \Delta T(x^{t+1}, y^{t+1}) \Delta TE(x^t, y^t, x^{t+1}, y^{t+1});$$

\*  $\Delta T(x^t, y^t)$  is the index of technical change between period's t and t+1 with respect to the data from period t, i.e. the shift to frontier technology between periods ;

\*  $\Delta TE(x^t, y^t, x^{t+1}, y^{t+1})$  is an index of technical efficiency changes between period's t and t+1.

## 3. The Input and Output Data.

We have chosen two inputs and two outputs. As inputs we decided to use *Investments, Employees*, and as outputs – the *Volume of Industrial Production and the Volume of Export*. (We would like to mention that in export tables we've included the intermediary export. As a result for some branches the volume of export is the biggest production volume) [7], [8].

We have performed two kinds of analyses, a static analysis and a dynamic analysis on a data set for 17 economical branches of Moldova in the 1993-1998 period. To compare the industrial branches among them we have transformed the data of Investments, Volume of Industrial Production and Volume of Export in dollars, then we have converted the data according to 1993 price. We performed the same actualize ting data and method

like [5].

#### 4. The productive analysis.

The distance functions are equivalent to Farrell's measure of technical efficiency [4], [5]. It follows that the distance function completely describes technology, and simultaneously provides a very useful measure of deviations from frontier performance of technical efficiency. The choice between weak and strong disposability is important for explaining the origin of inefficiency.

For the study of the technical efficiency of industrial branches we used a DEA model with two inputs and two outputs, assuming constant returns to scale and free disposability of inputs and outputs. We performed EMS for input and output orientations in order to construct the Malmquist productivity index, using the developed theory in [5]. The forward looking approach of Malmquist index, input and output oriented is:

$$M_i^{t+1}(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^{t+1}(y^t, x^t)}$$

$$M_0^{t+1}(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D_0^{t+1}(y^{t+1}, x^{t+1})}{D_0^{t+1}(y^t, x^t)}$$

This approach evaluates the performances of the data form period t and t+1 relative to technology (production possibilities) from period t+1.

#### 4.1 Forward input-oriented productive analysis

According to the registered economical data for the selected economical branches we calculated the efficiency scores for each year of the 1993-1998 period using the input and output structure for the DEA method. The scores of input-oriented analysis are annexed in Appendix 1. Further we calculated the Malmquist productive indexes of branches for the same branches and placed in Table 1.

**Malmquist productivity indexes. Table 1.**

Branches	93-'94	94-'95	95-96	96-'97	97-'98
Bakery prod.	0,315	0,237	0,3	0,36	0,514
Wood, furnit	0,053	0,213	65,7	2,52	1,318
Paper, art.	1,939	0,972	0,98	1,7	1,224
Rub. plast.	0,704	0,151	1,4	0,91	1,518
Leather, trunc	0,821	0,821	0,81	0,82	4,49
Food, drincs	0,661	0,855	1,05	0,89	2,964
Tobacco	0,491	1,078	0,33	0,44	0,877
Textile	0,427	1,177	0,8	1,17	0,748
Clothes, fur.	0,757	1,037	0,78	1,45	2,015
Soap, det.cos	2,097	0,272	0,74	4,67	4,342
Mineral prod.	1,209	1,041	1,03	0,73	1,108
Cement, lime	1,772	1,269	0,36	3,25	1,356
Mach., equipr	0,556	0,872	0,73	0,14	0,364
Foot- wear	2,857	2,142	1,03	0,7	1,307
Pharm., cherr	0,662	1,07	0,72	0,79	1,211
Records, TV	0,531	0,598	0,22	9,22	0,418
Ind. Wines	1,454	0,652	0,99	0,71	1,171

Analyzing the Malmquist Productivity indexes from Table 1 of the selected branches we can conclude:

1. the efficient branch of *Bakery production* is productive during the entire period 1993-1998, but decline in productivity startle 1995;
2. the *Machines and equipment's production and metaltreatment branch* is also productive during the entire period 1993-1998, but there is a decline in productivity in the period 1996-1997;
3. the situation is catastrophic for *Production of wood, wood products including furniture* in 1995-1996 period;
4. the productivity of the *Technical industry (equipment for record and reproduce of TV)* was unlucky with its considerable decline in 1996-1997 period that was not true in 1997-1998 when the productivity clearly went up
5. there was also noticed a drop in the productivity index in *Winemaking industry* in 1994-1995, later on followed by considerable rise in 1996-1998, combined with a degree of efficiency;
6. The dynamic evolution of Malmquist index for values close to 1 shows that the *Food-processing industry and drinks, Manufacture of tobacco articles* have been efficient. In Table2 and Table3 we presented the indexes of Malmquist productive decompositions according to the formula from § 2.1.

**The technical change indexes. Table 2.**

Branches	1993-94 ΔT	1994-95 ΔT	1995-96 ΔT	1996-97 ΔT	1997-98 ΔT
Bakery pro	0,1621	0,2279	0,2347	0,215	0,6737
Wood, furr	0,2118	0,0568	0,8793	1,2795	1,6558
Tobacco	1,0487	0,5926	1,1427	0,3914	0,7304
Soap,det.,c	0,8581	0,8331	0,5061	3,2275	1,166
Mach., equ	1,3291	0,8804	1,1681	1,1182	0,2403
Pharm.,chr	1,0681	0,6195	0,7952	0,8819	1,2858
Records, T	0,7739	0,6236	0,4377	4,6116	0,628

**The technical efficiency change indexes. Table 3.**

Branches	1993-94 ΔTE	1994-95 ΔTE	1995-96 ΔTE	1996-97 ΔTE	1997-98 ΔTE
Bakery prod.	1,9392	1,0371	1,2702	1,6551	0,7623
Wood, furnit.	0,2521	3,7385	74,708	1,9688	0,7958
Tobacco	0,4685	1,8187	0,2916	1,1293	1,2009
Soap,det,cos	2,4434	0,3229	1,4522	1,447	3,7239
Mach., equip	0,4185	0,9908	0,626	0,1287	1,5131
Pharm.,chen	0,6194	1,7629	0,9012	0,899	0,9419
Records, TV	0,1854	0,959	0,4913	1,9991	0,6818

According to the Tables 2 and 3 of Malmquist productivity indexes decomposition we state:

- the sudden change of productivity indexes in 1995-1996 in *Wood production including furniture* is due to the decrease of the efficiency technique index change (ΔTE); the decline in efficiency for the *Technical industry* in 1996-1997 has happened because of the index of technical change (ΔT);
- the value of all indices of technical change (ΔT) is growing during 1994-1995, these indices contributed to the rise of productivity and at the same time to the rise of the efficiency degree.

#### 4.2 Forward output-oriented productive analysis.

We provided the similarly output productive analysis using the efficiency scores from the Appendix 2 and obtained the Malmquist productive indexes placed from the next table.

**Malmquist productivity index – output oriented approach. Table 4**

Branches	93-'94	94-'95	95-'96	96-'97	97-'98
Bakery prod.	3,18	4,228	3,353	2,809	1,947
Wood, furnit	18,72	4,703	0,015	0,397	0,759
Paper, art.	0,516	1,029	1,017	0,59	0,817
Rub.plast.art.	1,42	6,624	0,417	1,1	0,659
Leather,trunk	1,218	1,218	1,23	1,225	0,223
Food, drinks	1,514	1,17	0,956	1,13	0,337
Tobacco	2,035	0,928	3	2,262	1,14
Textile	2,344	0,849	1,246	0,856	1,336
Clothes, fur.	1,321	0,965	1,288	0,69	0,496
Soap,de.,cos	0,477	3,672	1,36	0,214	0,23
Mineral prod.	0,827	0,961	0,971	1,366	0,903
Cement, lime	0,565	0,788	2,771	0,308	0,798
Mach.,equipr	1,797	1,146	1,367	6,946	2,75
Foot-wear	0,35	0,467	0,968	1,428	0,766
Pharm.,cherr	1,51	0,916	1,395	1,261	0,826
Records,TV	1,885	1,672	4,65	0,109	2,39
Ind.Wines	0,688	1,533	1,006	1,403	0,854

We effectuated the decomposition procedure of Malmquist productive indexes into indexes of technical efficiency change and indexes of technical change like the forward input productive analysis. The obtained decompositions indexes are placed in Table 5 and 6.

**The technique change indexes. Table 5.**

Branches	1993-94	1994-95	1995-96	1996-97	1997-98
	$\Delta T$	$\Delta T$	$\Delta T$	$\Delta T$	$\Delta T$
Bakery prod.	6,1642	4,3871	4,2589	4,649	1,4843
Wood, furnit.	4,7179	5825	1,1374	0,7815	0,6038
Tobacco	0,9535	1,6873	0,875	2,5544	13689
Soap,det,cos	1,1653	1,2003	1,9757	0,3098	0,8576
Mach., equip	0,7523	1,1358	0,8561	0,8942	4,1602
Pharm.,chem	0,9362	1,6141	1,2573	1,1338	0,7776
Records, TV	1,2919	1,6034	2,2844	0,2169	1,5923

**Efficiency technical change indexes. Table 6.**

Branches	1993-94	1994-95	1995-96	1996-97	1997-98
	$\Delta TE$	$\Delta TE$	$\Delta TE$	$\Delta TE$	$\Delta TE$
Bakery prod.	0,5159	0,9636	0,7873	0,6043	1,3169
Wood, furnit.	3,9678	0,252	0,0133	0,5078	1,2569
Tobacco	2,134	0,5498	3,4285	0,8854	0,8328
Soap,det,cos	0,4092	3,0588	0,6885	0,6911	0,2684
Mach., equip	2,3892	1,0093	1,5969	7,7667	0,6609
Pharm.,chen	1,6131	0,5672	1,1096	1,1121	1,0616
Records, TV	1,4589	1,0427	2,0354	0,5001	1,5006

Analyzing the scores of efficiency, Table 5 and 6, we state:

1. there are two economical branches efficient (the same as the previous analysis) during the entire period 1993-1998;

2. there are seven branches with no efficiency (as in the input oriented analysis) during 1993-1998; three branches were efficient just one year.
3. from the Table 5 and 6 of Malmquist productivity index decomposition we detect the same declines and growths for all economical branches (as the input oriented analysis), consequently the same positive or negative frontier shifts.

### 5. Conclusions

Analyzing the results of a forward-looking approach we can notice that the both productive indexes, input and output oriented, concerne:

- a) the same economic branches while surveying the efficiency and inefficiency (through the scores of efficiency);
- b) the same periods of growth and decline in productivity (through the Malmquist indices) ;
- c) the decomposition of Malmquist productivity indexes out to evidence the same factors ( $\Delta TE$ ,  $\Delta T$ ) (as in the input oriented analysis) provided the declines or growths in productivity for every branch.

In conclusion we can affirm, that the DEA technique is efficient concerning the study of the efficiency of any economic branch or sector. Evaluating the Malmquist-type coefficients, the DEA models permit to compare the actual efficiency of every branch with the optimal efficiency. Finally, it led to some theoretic solutions for the growth of economical indexes in the conditions of market economy [6].

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**Appendix 1.**

**Scores of Branches for input oriented analysis (%)**

Branches	1993Y	1994Y	1995Y	1996Y	1997Y	1998Y
Bakery prod.	1125	580,2	559,4	440,4	266,1	30
Wood, furnit	1156	4586	1227	16,42	8,34	10,48
Paper, art.	128,5	66,96	62,59	72,08	58,31	47,84
Rub.plast.art.	30,15	57,41	193,4	60,49	55,8	53,29
Leather,trunks	17,8	25,84	19,99	29,38	32,3	13,22
Food, drinks	53,96	87,54	58,86	77,38	66,65	42,09
Tobacco	79,8	170,3	93,64	321,1	284,3	236,7
Textile	46,68	73,59	45,92	56,23	94,39	134,8
Clothes, fur.	16,77	23,49	14,74	21,56	23,45	13,59
Soap,det.cosm	184,4	75,45	230,8	158,9	109,8	29,49
Mineral prod.	61,05	46,3	27,34	25,26	36,72	63,99
Cement, lime	8,66	6,54	3,94	9,14	10,36	8,29
Mach.,equipm	17,68	42,24	42,63	68,09	528,8	349,5
Foot-wear	18,03	7,89	3,79	4,14	8,33	6,94
Pharm.,chemi	104,7	168,9	95,79	106,3	118,2	125,5
Records,TV	110,2	160,8	167,6	341,1	170,6	256,1
Ind.Wines	61,06	46,13	48,84	48,46	66,2	92

**Appendix 2.**

**Scores of Branches for output oriented analysis (%)**

Branches	1993Y	1994Y	1995Y	1996Y	1997Y	1998Y
Bakery prod.	8,89	17,23	17,88	22,71	37,58	28,65
Wood, furnit	8,65	2,18	8,15	609	1199	954,17
Paper, art.	77,84	149,3	159,8	138,7	171,5	209,04
Rub.plast.art.	331,6	174,2	51,71	165,3	179,2	187,67
Leather,trunks	561,9	387	500,2	340,3	309,6	756,21
Food, drinks	185,3	114,2	169,9	129,2	150	237,57
Tobacco	125,3	58,72	106,8	31,15	35,18	42,24
Textile	214,2	135,9	217,8	177,9	106	74,19
Clothes, fur.	596,4	425,7	678,4	463,8	426,4	735,9
Soap,de.,cosm	54,24	132,5	43,33	62,93	91,05	339,11
Mineral prod.	163,8	216	365,8	395,9	272,3	156,28
Cement, lime	1155	1528	2537	1095	965,3	1205,7
Mach.,equipm	565,7	236,8	234,6	146,9	18,91	28,61
Foot-wear	554,5	1267	2635	2417	1200	1440,1
Pharm.,chemi	95,53	59,22	104,4	94,08	84,59	79,68
Records,TV	90,76	62,21	59,66	29,31	58,6	39,05
Ind.Wines	163,8	216,8	204,7	206,4	151,1	108,7

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