User's Guide for Malmquist Index Research For DEA models

Book **1**

KonSi Malmquist Index Software

For Data Envelopment Analysis Models

1 INTODUCTION

KonSi – Malmquist Index software uses method of calculation Malmquist index is prepared in following papers:

Fare R, Grosskopf S, Lindgren B, Roos P. Productivity changes in Swedish pharamacies 1980-1989: A non-parametric Malmquist approach. J Prod Anal. 1992; 3(1-2): 85-101.

Fare R, Grosskopf S, Norris M, Zhang Z. Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. Am Econ Rev. 1994; 84(1): 66-83.

$$M^{t,t+1} = \underbrace{\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t}(x^{t}, y^{t})}}_{\text{Efficiency change (EC)}} \times \underbrace{\left[\frac{D^{t}(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \frac{D^{t}(x^{t}, y^{t})}{D^{t+1}(x^{t}, y^{t})} \right]^{1/2}}_{\text{Technical change (TC)}}$$

M = EC * TC = PC * SC * TC

M - malmquist index

EC - change in efficiency

TC - technical change

PC - Pure efficiency change

SC - scale efficiency change

2 METHODS OF MALMQUIST INDEX CALCULATION

KonSi – Malmquist Index software allows you to calculate Malmquist index using three calculation methods:

- Fixed base;
- Adjacent base;
- Seasonal calculation.

Fixed base Malmquist Index Method

Usage of the fixed-base calculation method assumes that you select one of researched time moments as a base moment. All further calculations are performed relative to this base moment. This calculation method is illustrated on Figure 1.

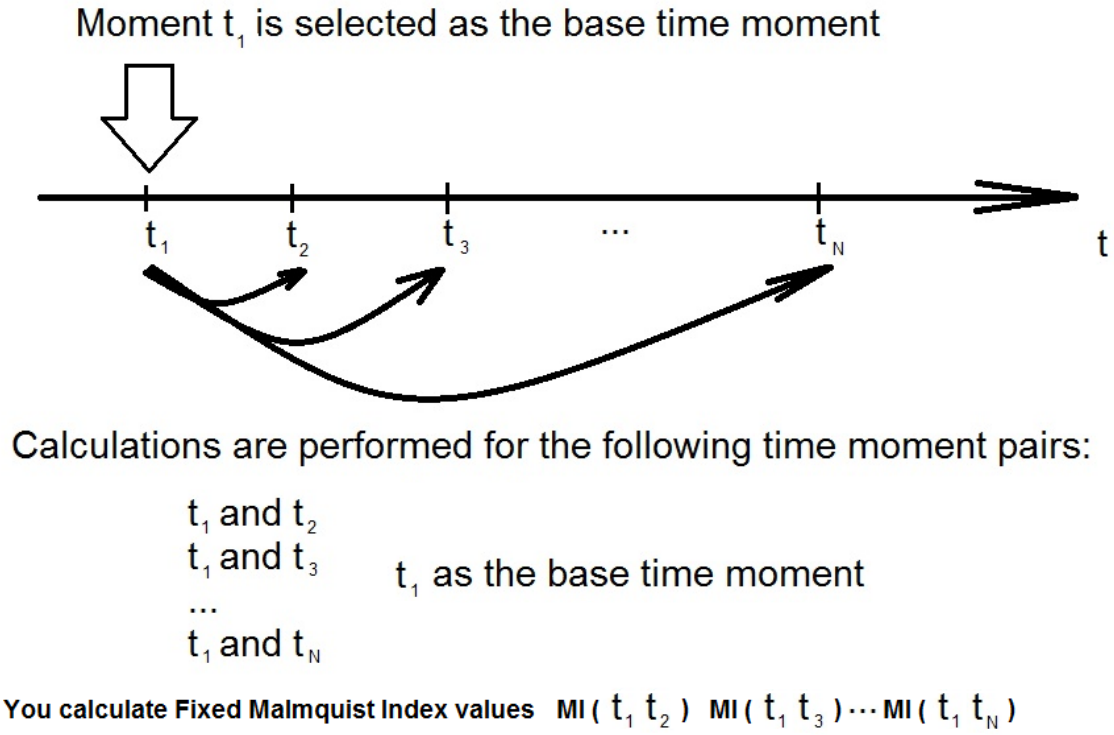


Figure 1 Fixed-base method of Malmquist index calculation

Adjacent-base Malmquist Index method

Usage of the adjacent-base calculation method assumes that each time moment is selected as the base moment and the moment next to base is considered as the analyzed time moment. This calculation method is illustrated on Figure 2.

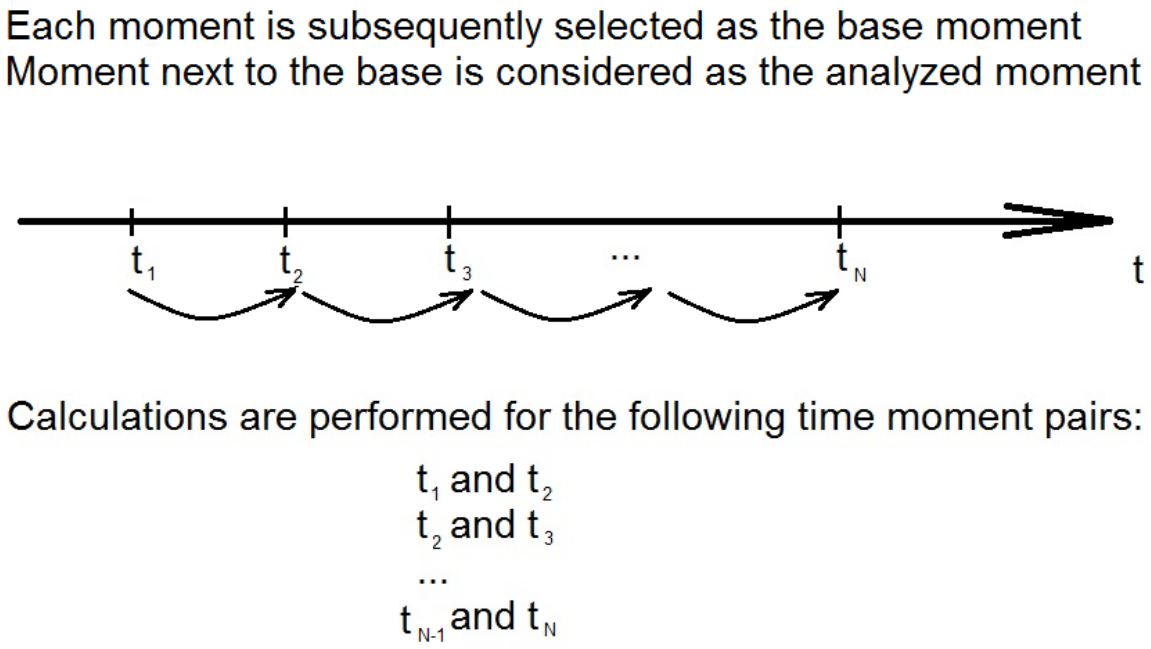


Figure 2 Adjacent-base method of Malmquist index calculation

Seasonal Malmquist Index method

Usage of the seasonal calculation method assumes that each of the moments is considered as the base moment and the analyzed moment is shifted to a given number of time moments ("season length") relative to the base. This calculation method is illustrated on Figure 3. In the example shown on this illustration, the season length parameter is set to 2.

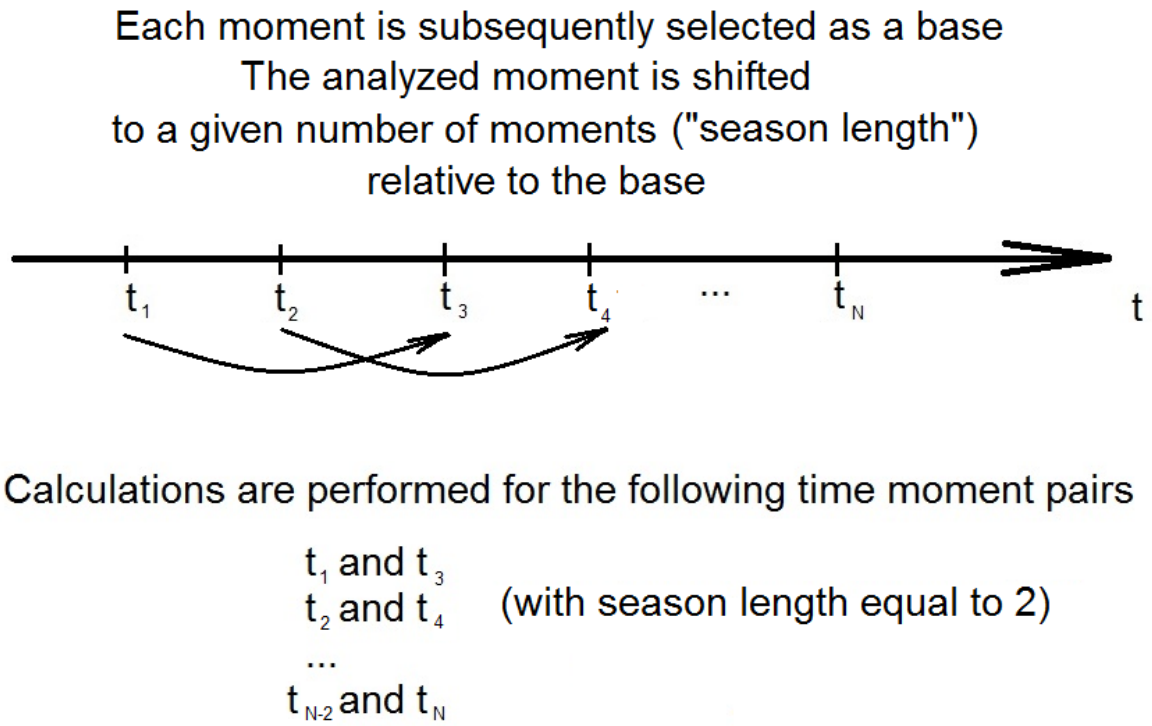


Figure 3 Seasonal method of Malmquist index calculation

Seasonal method is useful when it is necessary to calculate Malmquist index for periodical data (e.g. annual, quarterly, monthly data etc.). For example, if you are analyzing monthly data for many years and need to compare the same month in two years, you may use this method with season length set to 12 months. This allows you to compare January data in one year with January data in the other year, February data in one year with February data in the other year etc.

3 REPORTS ABOUT MALMQUIST INDEX VALUES

KonSi - Malmquist Index Software allows you to calculate Malmquist Index values, their components and CRS – VRS efficiencies used for calculation of indexes. The program generates five reports and saves them as .csv files. The reports are named in the following way:

- **Rpt1_MalmReportsDescription** – a report explaining terms or names used in other generated reports;
- **Rpt2_MI** – a report containing Malmquist index and its components computed for your dataset;
- **Rpt3_MalmEff** - a report containing DEA efficiencies computed during Malmquist index calculation;
- **Rpt4_DataForRegression** – a report containing data about Malmquist index, its components, DEA efficiencies computed during Malmquist index calculation and parameters of researched objects. This report may be used as source data for researching regression relationship between Malmquist Index and parameters of analyzed objects.
- **Rpt5_DataForPivotTable** – a report containing data about Malmquist index, its components, DEA efficiencies and object parameters. This report may be used as source data for creating table reports using MS Excel tools, for example, a pivot table.

3.1 Rpt1. Terms and names used in reports

This report is saved under the name **Rpt1_MalmReportsDescription**. The report allows you to get information about terms or names used in other generated reports. This report is generated as a .csv file which you may study using Microsoft Excel. The contents of this report are shown on Figure 4 - Figure 5.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Rpt2_MI_AdjacentBase.csv	Report on Malmquist index components (calculation method: adjacent base time)										
2	DMU	Researched object										
3	t-1	Base time moment										
4	t	New time moment										
5	EC	Efficiency change										
6	PC	Pure efficiency change										
7	SC	Scale efficiency change										
8	TC	Technology change										
9	MI	Malmquist index										
10	Rpt3_Eff_AdjacentBase.csv	Report on efficiencies used for computing Malmquist index (calculation method: adjacent base time)										
11	DMU	Researched object										
12	t-1	Base time moment										
13	t	New time moment										
14	CRS(t-1)	CRS efficiency in base moment relative to base frontier										
15	CRS(t)	CRS efficiency in analyzed moment relative to new frontier										
16	CRSMix(t,t-1)	CRS efficiency in analyzed moment relative to base frontier										
17	CRSMix2(t-1,t)	CRS efficiency in base moment relative to new frontier										
18	VRS(t-1)	VRS efficiency in base moment relative to base frontier										
19	VRS(t)	VRS efficiency in analyzed moment relative to new frontier										
20	Rpt4_DataForRegression.csv	Report containing data for Malmquist index regression analysis										
21	Rpt5_DataForPivotTable.csv	Report containing data for Excel pivot table preparation										

Figure 4 **Rpt1_MalmReportsDescription**. Report on terms and names viewed as an Excel table

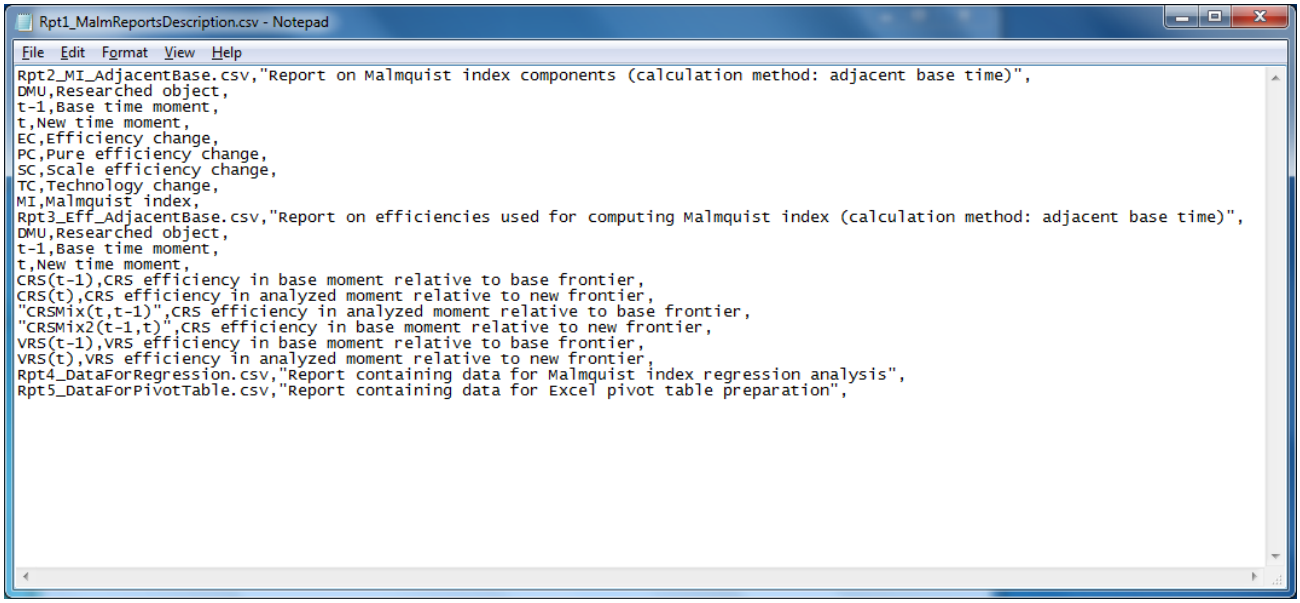
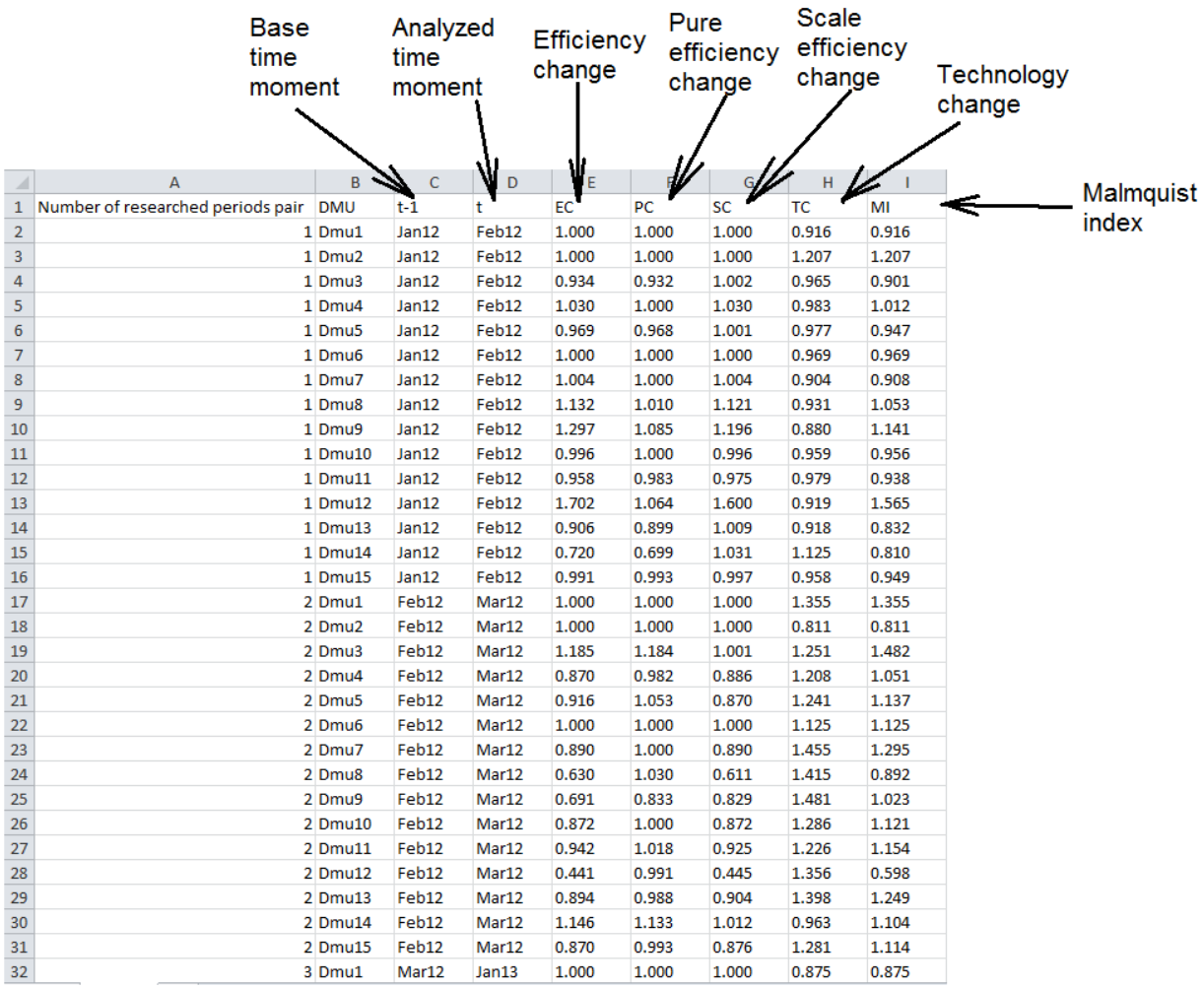


Figure 5 **Rpt1_MalmReportsDescription**. Report on terms and names viewed in Notepad

3.2 Rpt2. Malmquist index and its components

This report is saved under the name **Rpt2_MI**. The report contains values of the Malmquist index and its components computed for your dataset. This report is generated as a .csv file which you may study using Microsoft Excel. The contents of this report are shown on Figure 6 - Figure 7.



	A	B	C	D	E	F	G	H	I
1	Number of researched periods pair	DMU	t-1	t	EC	PC	SC	TC	MI
2	1	Dmu1	Jan12	Feb12	1.000	1.000	1.000	0.916	0.916
3	1	Dmu2	Jan12	Feb12	1.000	1.000	1.000	1.207	1.207
4	1	Dmu3	Jan12	Feb12	0.934	0.932	1.002	0.965	0.901
5	1	Dmu4	Jan12	Feb12	1.030	1.000	1.030	0.983	1.012
6	1	Dmu5	Jan12	Feb12	0.969	0.968	1.001	0.977	0.947
7	1	Dmu6	Jan12	Feb12	1.000	1.000	1.000	0.969	0.969
8	1	Dmu7	Jan12	Feb12	1.004	1.000	1.004	0.904	0.908
9	1	Dmu8	Jan12	Feb12	1.132	1.010	1.121	0.931	1.053
10	1	Dmu9	Jan12	Feb12	1.297	1.085	1.196	0.880	1.141
11	1	Dmu10	Jan12	Feb12	0.996	1.000	0.996	0.959	0.956
12	1	Dmu11	Jan12	Feb12	0.958	0.983	0.975	0.979	0.938
13	1	Dmu12	Jan12	Feb12	1.702	1.064	1.600	0.919	1.565
14	1	Dmu13	Jan12	Feb12	0.906	0.899	1.009	0.918	0.832
15	1	Dmu14	Jan12	Feb12	0.720	0.699	1.031	1.125	0.810
16	1	Dmu15	Jan12	Feb12	0.991	0.993	0.997	0.958	0.949
17	2	Dmu1	Feb12	Mar12	1.000	1.000	1.000	1.355	1.355
18	2	Dmu2	Feb12	Mar12	1.000	1.000	1.000	0.811	0.811
19	2	Dmu3	Feb12	Mar12	1.185	1.184	1.001	1.251	1.482
20	2	Dmu4	Feb12	Mar12	0.870	0.982	0.886	1.208	1.051
21	2	Dmu5	Feb12	Mar12	0.916	1.053	0.870	1.241	1.137
22	2	Dmu6	Feb12	Mar12	1.000	1.000	1.000	1.125	1.125
23	2	Dmu7	Feb12	Mar12	0.890	1.000	0.890	1.455	1.295
24	2	Dmu8	Feb12	Mar12	0.630	1.030	0.611	1.415	0.892
25	2	Dmu9	Feb12	Mar12	0.691	0.833	0.829	1.481	1.023
26	2	Dmu10	Feb12	Mar12	0.872	1.000	0.872	1.286	1.121
27	2	Dmu11	Feb12	Mar12	0.942	1.018	0.925	1.226	1.154
28	2	Dmu12	Feb12	Mar12	0.441	0.991	0.445	1.356	0.598
29	2	Dmu13	Feb12	Mar12	0.894	0.988	0.904	1.398	1.249
30	2	Dmu14	Feb12	Mar12	1.146	1.133	1.012	0.963	1.104
31	2	Dmu15	Feb12	Mar12	0.870	0.993	0.876	1.281	1.114
32	3	Dmu1	Mar12	Jan13	1.000	1.000	1.000	0.875	0.875

Figure 6 Rpt2_MI Report on Malmquist index and its components displayed as an Excel table

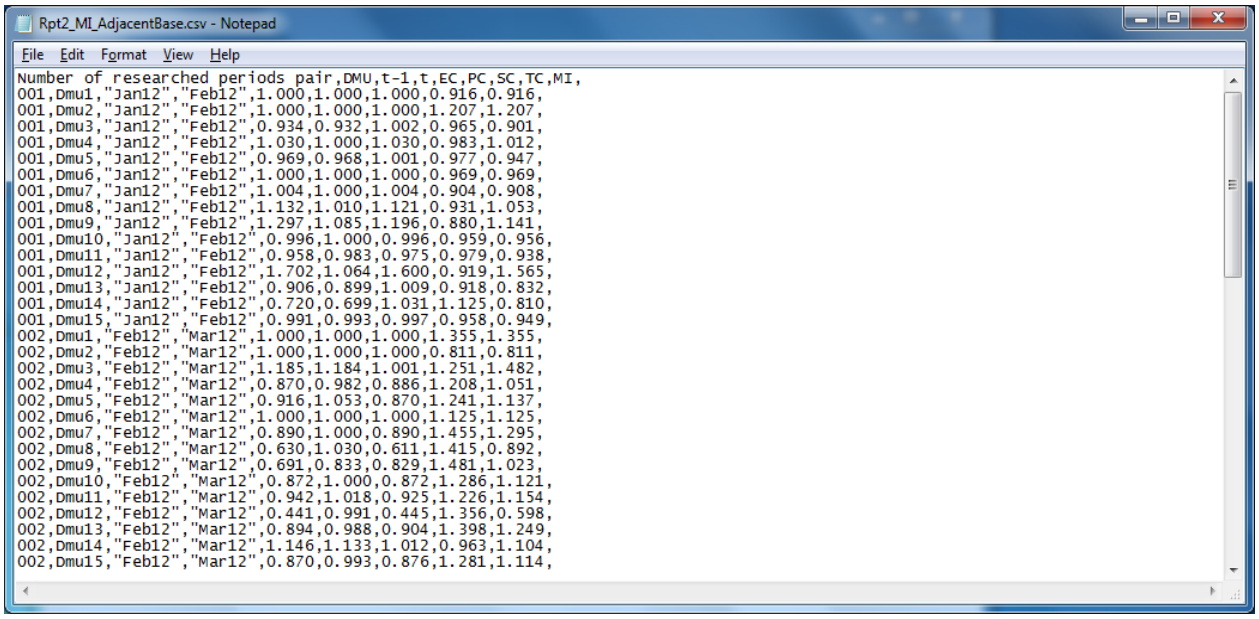


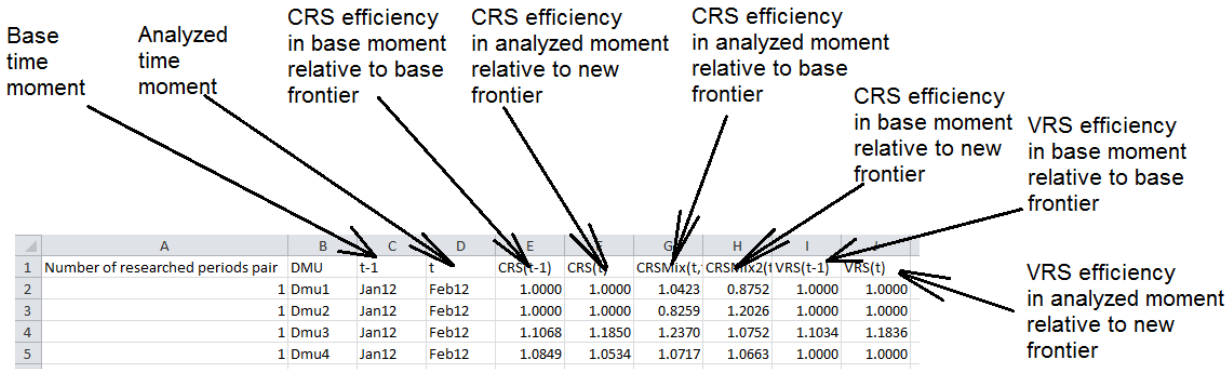
Figure 7 Rpt2_MI Report on Malmquist index and its components viewed in Notepad

The following elements are added to the report name depending on the Malmquist index calculation method:

- Method used for Malmquist index calculation, which was selected in the **Malmquist Index Calculation** window. This element may have one of the following values:
  - "FixedBase" which means that the Malmquist index and its components are computed using fixed-base method, i.e. one time moment is selected as a base time and the calculation is performed relative to that particular base time moment.
  - "Adjacent" which means that the Malmquist index and its components are computed using adjacent-base method, i.e. each moment is considered as a base moment and the moment next to the base is considered as the analyzed moment.
  - "Seasonal" which means that the Malmquist index and its components are computed using seasonal calculation method, i.e. each of the periods is used as a base time moment and the analyzed time moment is shifted to a given number of time moments relative to the base time moment.
- Method-specific options which are as follows:
  - "BasePeriod_Name" (for fixed-base calculation method) – an option indicating name of the time moment selected as a fixed base for computing Malmquist index
  - "ShiftValue_Value" (for seasonal calculation method) – an option indicating the number of time moments to which analyzed moments are shifted relative to base moments when "Seasonal" method is selected.

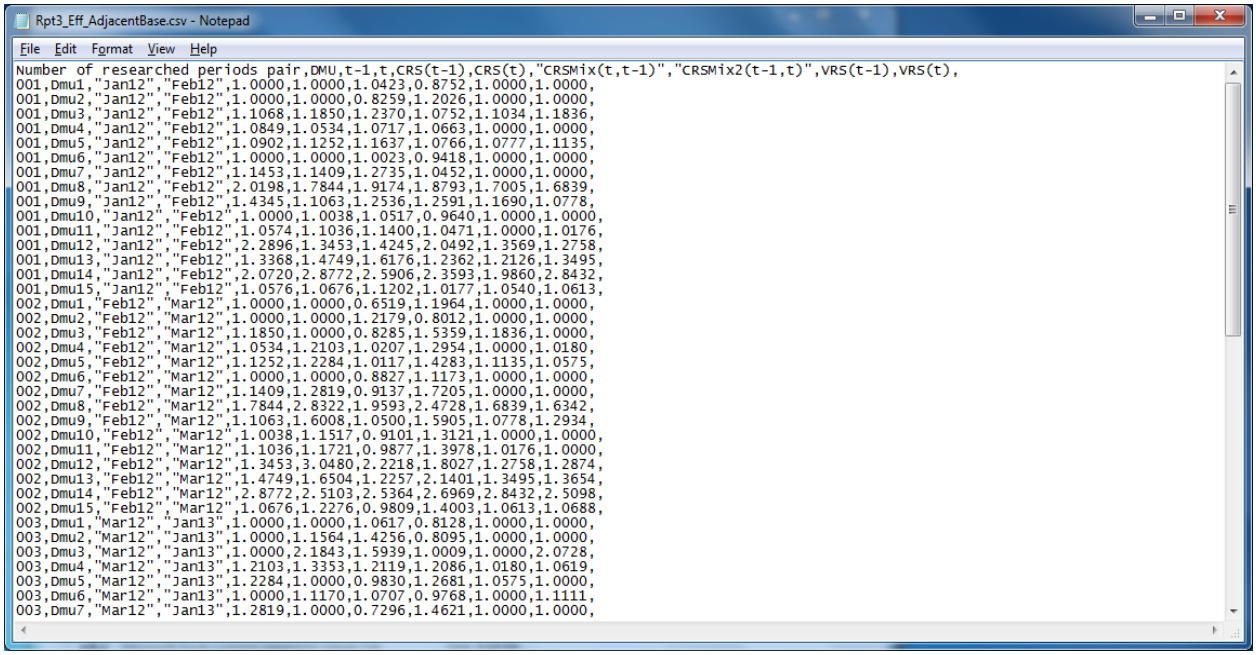
3.3 Rpt3. DEA efficiencies computed during Malmquist index calculation

This report is saved under the name **Rpt3_MalmEff**. The report allows you to get information about CRS and VRS efficiencies computed during Malmquist index calculation. This report is generated as a .csv file which you may study using Microsoft Excel. The contents of this report are shown on Figure 8 - Figure 9.



	A	B	C	D	E	F	G	H	I	J
1	Number of researched periods pair	DMU	t-1	t	CRS(t-1)	CRS(t)	CRSMix(t,	CRSMix2(t	VRS(t-1)	VRS(t)
2	1	Dmu1	Jan12	Feb12	1.0000	1.0000	1.0423	0.8752	1.0000	1.0000
3	1	Dmu2	Jan12	Feb12	1.0000	1.0000	0.8259	1.2026	1.0000	1.0000
4	1	Dmu3	Jan12	Feb12	1.1068	1.1850	1.2370	1.0752	1.1034	1.1836
5	1	Dmu4	Jan12	Feb12	1.0849	1.0534	1.0717	1.0663	1.0000	1.0000
6	1	Dmu5	Jan12	Feb12	1.0902	1.1252	1.1637	1.0766	1.0777	1.1135
7	1	Dmu6	Jan12	Feb12	1.0000	1.0000	1.0023	0.9418	1.0000	1.0000
8	1	Dmu7	Jan12	Feb12	1.1453	1.1409	1.2735	1.0452	1.0000	1.0000
9	1	Dmu8	Jan12	Feb12	2.0198	1.7844	1.9174	1.8793	1.7005	1.6839
10	1	Dmu9	Jan12	Feb12	1.4345	1.1063	1.2536	1.2591	1.1690	1.0778
11	1	Dmu10	Jan12	Feb12	1.0000	1.0038	1.0517	0.9640	1.0000	1.0000
12	1	Dmu11	Jan12	Feb12	1.0574	1.1036	1.1400	1.0471	1.0000	1.0176
13	1	Dmu12	Jan12	Feb12	2.2896	1.3453	1.4245	2.0492	1.3569	1.2758
14	1	Dmu13	Jan12	Feb12	1.3368	1.4749	1.6176	1.2362	1.2126	1.3495
15	1	Dmu14	Jan12	Feb12	2.0720	2.8772	2.5906	2.3593	1.9860	2.8432
16	1	Dmu15	Jan12	Feb12	1.0576	1.0676	1.1202	1.0177	1.0540	1.0613
17	2	Dmu1	Feb12	Mar12	1.0000	1.0000	0.6519	1.1964	1.0000	1.0000
18	2	Dmu2	Feb12	Mar12	1.0000	1.0000	1.2179	0.8012	1.0000	1.0000
19	2	Dmu3	Feb12	Mar12	1.1850	1.0000	0.8285	1.5359	1.1836	1.0000
20	2	Dmu4	Feb12	Mar12	1.0534	1.2103	1.0207	1.2954	1.0000	1.0180
21	2	Dmu5	Feb12	Mar12	1.1252	1.2284	1.0117	1.4283	1.1135	1.0575
22	2	Dmu6	Feb12	Mar12	1.0000	1.0000	0.8827	1.1173	1.0000	1.0000
23	2	Dmu7	Feb12	Mar12	1.1409	1.2819	0.9137	1.7205	1.0000	1.0000
24	2	Dmu8	Feb12	Mar12	1.7844	2.8322	1.9593	2.4728	1.6839	1.6342
25	2	Dmu9	Feb12	Mar12	1.1063	1.6008	1.0500	1.5905	1.0778	1.2934
26	2	Dmu10	Feb12	Mar12	1.0038	1.1517	0.9101	1.3121	1.0000	1.0000
27	2	Dmu11	Feb12	Mar12	1.1036	1.1721	0.9877	1.3978	1.0176	1.0000
28	2	Dmu12	Feb12	Mar12	1.3453	3.0480	2.2218	1.8027	1.2758	1.2874
29	2	Dmu13	Feb12	Mar12	1.4749	1.6504	1.2257	2.1401	1.3495	1.3654
30	2	Dmu14	Feb12	Mar12	2.8772	2.5103	2.5364	2.6969	2.8432	2.5098
31	2	Dmu15	Feb12	Mar12	1.0676	1.2276	0.9809	1.4003	1.0613	1.0688
32	3	Dmu1	Mar12	Jan13	1.0000	1.0000	1.0617	0.8128	1.0000	1.0000

Figure 8 Rpt3_MalmEff - a report containing DEA efficiencies computed during Malmquist index calculation. Efficiencies report is displayed as an Excel table


Rpt3_Eff_AdjacentBase.csv - Notepad

File Edit Format View Help

```
Number of researched periods pair,DMU,t-1,t,CRS(t-1),CRS(t),"CRSMix(t,t-1)","CRSMix2(t-1,t)",VRS(t-1),VRS(t),
001,Dmu1,"Jan12","Feb12",1.0000,1.0000,1.0423,0.8752,1.0000,1.0000,
001,Dmu2,"Jan12","Feb12",1.0000,1.0000,0.8259,1.2026,1.0000,1.0000,
001,Dmu3,"Jan12","Feb12",1.1068,1.1850,1.2370,1.0752,1.1034,1.1836,
001,Dmu4,"Jan12","Feb12",1.0849,1.0534,1.0717,1.0663,1.0000,1.0000,
001,Dmu5,"Jan12","Feb12",1.0902,1.1252,1.1637,1.0766,1.0777,1.1135,
001,Dmu6,"Jan12","Feb12",1.0000,1.0000,1.0023,0.9418,1.0000,1.0000,
001,Dmu7,"Jan12","Feb12",1.1453,1.1409,1.2735,1.0452,1.0000,1.0000,
001,Dmu8,"Jan12","Feb12",2.0198,1.7844,1.9174,1.8793,1.7005,1.6839,
001,Dmu9,"Jan12","Feb12",1.4345,1.1063,1.2536,1.2591,1.1690,1.0778,
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001,Dmu11,"Jan12","Feb12",1.0574,1.1036,1.1400,1.0471,1.0000,1.0176,
001,Dmu12,"Jan12","Feb12",2.2896,1.3453,1.4245,2.0492,1.3569,1.2758,
001,Dmu13,"Jan12","Feb12",1.3368,1.4749,1.6176,1.2362,1.2126,1.3495,
001,Dmu14,"Jan12","Feb12",2.0720,2.8772,2.5906,2.3593,1.9860,2.8432,
001,Dmu15,"Jan12","Feb12",1.0576,1.0676,1.1202,1.0177,1.0540,1.0613,
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002,Dmu2,"Feb12","Mar12",1.0000,1.0000,1.2179,0.8012,1.0000,1.0000,
002,Dmu3,"Feb12","Mar12",1.1850,1.0000,0.8285,1.5359,1.1836,1.0000,
002,Dmu4,"Feb12","Mar12",1.0534,1.2103,1.0207,1.2954,1.0000,1.0180,
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002,Dmu7,"Feb12","Mar12",1.1409,1.2819,0.9137,1.7205,1.0000,1.0000,
002,Dmu8,"Feb12","Mar12",1.7844,2.8322,1.9593,2.4728,1.6839,1.6342,
002,Dmu9,"Feb12","Mar12",1.1063,1.6008,1.0500,1.5905,1.0778,1.2934,
002,Dmu10,"Feb12","Mar12",1.0038,1.1517,0.9101,1.3121,1.0000,1.0000,
002,Dmu11,"Feb12","Mar12",1.1036,1.1721,0.9877,1.3978,1.0176,1.0000,
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002,Dmu13,"Feb12","Mar12",1.4749,1.6504,1.2257,2.1401,1.3495,1.3654,
002,Dmu14,"Feb12","Mar12",2.8772,2.5103,2.5364,2.6969,2.8432,2.5098,
002,Dmu15,"Feb12","Mar12",1.0676,1.2276,0.9809,1.4003,1.0613,1.0688,
003,Dmu1,"Mar12","Jan13",1.0000,1.0000,1.0617,0.8128,1.0000,1.0000,
003,Dmu2,"Mar12","Jan13",1.0000,1.1564,1.4256,0.8095,1.0000,1.0000,
003,Dmu3,"Mar12","Jan13",1.0000,2.1843,1.5939,1.0009,1.0000,2.0728,
003,Dmu4,"Mar12","Jan13",1.2103,1.3353,1.2119,1.2086,1.0180,1.0619,
003,Dmu5,"Mar12","Jan13",1.2284,1.0000,0.9830,1.2681,1.0575,1.0000,
003,Dmu6,"Mar12","Jan13",1.0000,1.1170,1.0707,0.9768,1.0000,1.1111,
003,Dmu7,"Mar12","Jan13",1.2819,1.0000,0.7296,1.4621,1.0000,1.0000,
```

Figure 9 Rpt3_MalmEff - a report containing DEA efficiencies computed during Malmquist index calculation. Efficiencies report viewed in Notepad

The following elements are added to the report name depending on the Malmquist index calculation method:

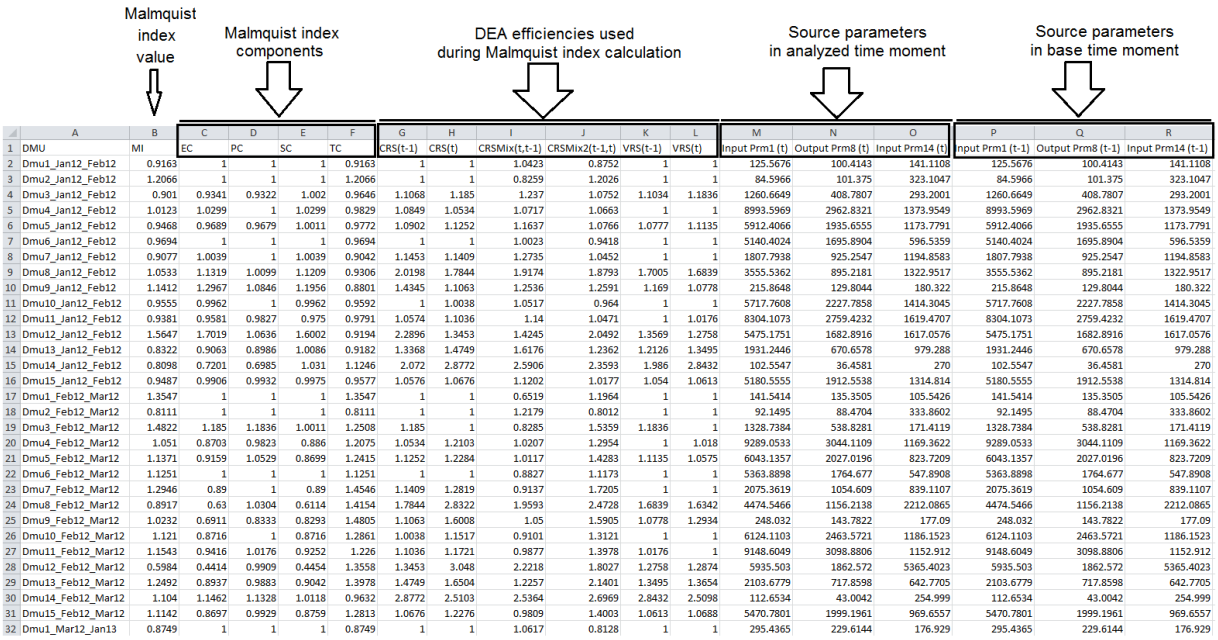
- Method used for Malmquist index calculation, which was selected in the **Malmquist Index Calculation** window. This element may have one of the following values:
  - "FixedBase" which means that the Malmquist index and its components are computed using fixed-base method, i.e. one time moment is selected as a base time and the calculation is performed relative to that particular base time moment.
  - "Adjacent" which means that the Malmquist index and its components are computed using adjacent-base method, i.e. each moment is considered as a base moment and the moment next to the base is considered as the analyzed moment.
  - "Seasonal" which means that the Malmquist index and its components are computed using seasonal calculation method, i.e. each of the periods is used as a base time moment and the analyzed time moment is shifted to a given number of time moments relative to the base time moment.
- Method-specific options which are as follows:
  - "BasePeriod_Name" (for fixed-base calculation method) – an option indicating name of the time moment selected as a fixed base for computing Malmquist index
  - "ShiftValue_Value" (for seasonal calculation method) – an option indicating the number of time moments to which analyzed moments are shifted relative to base moments when "Seasonal" method is selected.

3.4 Rpt4. Terms and names used in reports

This report is saved under the name **Rpt4_DataForRegression**. This report contains data about Malmquist index, its components, DEA efficiencies computed during Malmquist index calculation and parameters of researched objects.

This report may be used **for regression analysis**. You may use Malmquist index value as a dependent variable and other data as independent variables. You may use KonSi-Stepwise Regression Analysis Software to research relationships between parameters contained in the report. The contents of this report are used as source data for regression analysis.

This report is generated as a .csv file which you may study using Microsoft Excel. The contents of this report are shown on Figure 10 - Figure 11.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	DMU	MI	EC	PC	SC	TC	CRS(t-1)	CRS(t)	CRSMix(t,t-1)	CRSMix2(t-1,t)	VRS(t-1)	VRS(t)	Input Prm1 (t)	Output Prm8 (t)	Input Prm14 (t)	Input Prm1 (t-1)	Output Prm8 (t-1)	Input Prm14 (t-1)
2	Dmu1_Jan12_Feb12	0.9163	1	1	1	0.9163	1	1	1.0423	0.8752	1	1	125.5676	100.4143	141.1108	125.5676	100.4143	141.1108
3	Dmu2_Jan12_Feb12	1.2066	1	1	1	1.2066	1	1	0.8259	1.2026	1	1	84.5966	101.375	323.1047	84.5966	101.375	323.1047
4	Dmu3_Jan12_Feb12	0.901	0.9341	0.9322	1.002	0.9646	1.1068	1.185	1.237	1.0752	1.1034	1.1836	1260.6649	408.7807	293.2001	1260.6649	408.7807	293.2001
5	Dmu4_Jan12_Feb12	1.0123	1.0299	1	1.0299	0.9829	1.0849	1.0534	1.0717	1.0663	1	1	8993.5969	2962.8321	1373.9549	8993.5969	2962.8321	1373.9549
6	Dmu5_Jan12_Feb12	0.9468	0.9689	0.9679	1.0011	0.9772	1.0902	1.1252	1.1637	1.0766	1.0777	1.1135	5912.4066	1935.6555	1173.7791	5912.4066	1935.6555	1173.7791
7	Dmu6_Jan12_Feb12	0.9694	1	1	1	0.9694	1	1	1.0023	0.9418	1	1	5140.4024	1695.8904	596.5359	5140.4024	1695.8904	596.5359
8	Dmu7_Jan12_Feb12	0.9077	1.0039	1	1.0039	0.9042	1.1453	1.1409	1.2735	1.0452	1	1	1807.7938	925.2547	1194.8583	1807.7938	925.2547	1194.8583
9	Dmu8_Jan12_Feb12	1.0533	1.1319	1.0099	1.1209	0.9306	2.0198	1.7844	1.9174	1.8793	1.7005	1.6839	3555.5362	895.2181	1322.9517	3555.5362	895.2181	1322.9517
10	Dmu9_Jan12_Feb12	1.1412	1.2967	1.0846	1.1956	0.8801	1.4345	1.1063	1.2536	1.2591	1.169	1.0778	215.8648	129.8044	180.322	215.8648	129.8044	180.322
11	Dmu10_Jan12_Feb12	0.9555	0.9962	1	0.9962	0.9592	1	1.0038	1.0517	0.964	1	1	5717.7608	2227.7858	1414.3045	5717.7608	2227.7858	1414.3045
12	Dmu11_Jan12_Feb12	0.9381	0.9581	0.9827	0.975	0.9791	1.0574	1.1036	1.14	1.0471	1	1.0176	8304.1073	2759.4232	1619.4707	8304.1073	2759.4232	1619.4707
13	Dmu12_Jan12_Feb12	1.5647	1.7019	1.0636	1.6002	0.9194	2.2896	1.3453	1.4245	2.0492	1.3569	1.2758	5475.1751	1682.8916	1617.0576	5475.1751	1682.8916	1617.0576
14	Dmu13_Jan12_Feb12	0.8322	0.9063	0.8986	1.0086	0.9182	1.3368	1.4749	1.6176	1.2362	1.2126	1.3495	1931.2446	670.6578	979.288	1931.2446	670.6578	979.288
15	Dmu14_Jan12_Feb12	0.8098	0.7201	0.6985	1.031	1.1246	2.072	2.8772	2.5906	2.3593	1.986	2.8432	102.5547	36.4581	270	102.5547	36.4581	270
16	Dmu15_Jan12_Feb12	0.9487	0.9906	0.9932	0.9975	0.9577	1.0576	1.0676	1.1202	1.0177	1.054	1.0613	5180.5555	1912.5538	1314.814	5180.5555	1912.5538	1314.814
17	Dmu1_Feb12_Mar12	1.3547	1	1	1	1.3547	1	1	0.6519	1.1964	1	1	141.5414	135.3505	105.5426	141.5414	135.3505	105.5426
18	Dmu2_Feb12_Mar12	0.8111	1	1	1	0.8111	1	1	1.2179	0.8012	1	1	92.1495	88.4704	333.8602	92.1495	88.4704	333.8602
19	Dmu3_Feb12_Mar12	1.4822	1.185	1.1836	1.0011	1.2508	1.185	1	0.8285	1.5359	1.1836	1	1328.7384	538.8281	171.4119	1328.7384	538.8281	171.4119
20	Dmu4_Feb12_Mar12	1.051	0.8703	0.9823	0.886	1.2075	1.0534	1.2103	1.0207	1.2954	1	1.018	9289.0533	3044.1109	1169.3622	9289.0533	3044.1109	1169.3622
21	Dmu5_Feb12_Mar12	1.1371	0.9159	1.0529	0.8699	1.2415	1.1252	1.2284	1.0117	1.4283	1.1135	1.0575	6043.1357	2027.0196	823.7209	6043.1357	2027.0196	823.7209
22	Dmu6_Feb12_Mar12	1.1251	1	1	1	1.1251	1	1	0.8827	1.1173	1	1	5363.8898	1764.677	547.8908	5363.8898	1764.677	547.8908
23	Dmu7_Feb12_Mar12	1.2946	0.89	1	0.89	1.4546	1.1409	1.2819	0.9137	1.7205	1	1	2075.3619	1054.609	839.1107	2075.3619	1054.609	839.1107
24	Dmu8_Feb12_Mar12	0.8917	0.63	1.0304	0.6114	1.4154	1.7844	2.8322	1.9593	2.4728	1.6839	1.6342	4474.5466	1156.2138	2212.0865	4474.5466	1156.2138	2212.0865
25	Dmu9_Feb12_Mar12	1.0232	0.6911	0.8333	0.8293	1.4805	1.1063	1.6008	1.05	1.5905	1.0778	1.2934	248.032	143.7822	177.09	248.032	143.7822	177.09
26	Dmu10_Feb12_Mar12	1.121	0.8716	1	0.8716	1.2861	1.0038	1.1517	0.9101	1.3121	1	1	6124.1103	2463.5721	1186.1523	6124.1103	2463.5721	1186.1523
27	Dmu11_Feb12_Mar12	1.1543	0.9416	1.0176	0.9252	1.226	1.1036	1.1721	0.9877	1.3978	1.0176	1	9148.6049	3098.8806	1152.912	9148.6049	3098.8806	1152.912
28	Dmu12_Feb12_Mar12	0.5984	0.4414	0.9909	0.4454	1.3558	1.3453	3.048	2.2218	1.8027	1.2758	1.2874	5935.503	1862.572	5365.4023	5935.503	1862.572	5365.4023
29	Dmu13_Feb12_Mar12	1.2492	0.8937	0.9883	0.9042	1.3978	1.4749	1.6504	1.2257	2.1401	1.3495	1.3654	2103.6779	717.8598	642.7705	2103.6779	717.8598	642.7705
30	Dmu14_Feb12_Mar12	1.104	1.1462	1.1328	1.0118	0.9632	2.8772	2.5103	2.5364	2.6969	2.8432	2.5098	112.6534	43.0042	254.999	112.6534	43.0042	254.999
31	Dmu15_Feb12_Mar12	1.1142	0.8697	0.9929	0.8759	1.2813	1.0676	1.2276	0.9809	1.4003	1.0613	1.0688	5470.7801	1999.1961	969.6557	5470.7801	1999.1961	969.6557
32	Dmu1_Mar12_Jan13	0.8749	1	1	1	0.8749	1	1	1.0617	0.8128	1	1	295.4365	229.6144	176.929	295.4365	229.6144	176.929

Figure 10 Rpt4_DataForRegression. Report with joined data on Malmquist index and source object parameters displayed as an Excel table

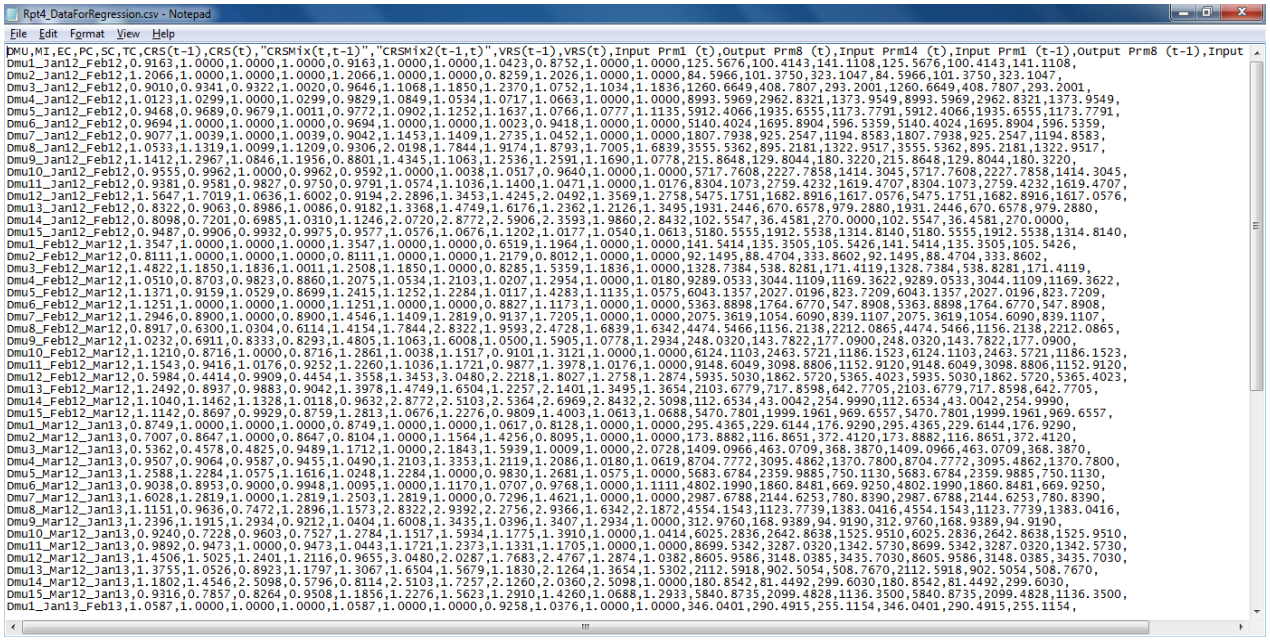
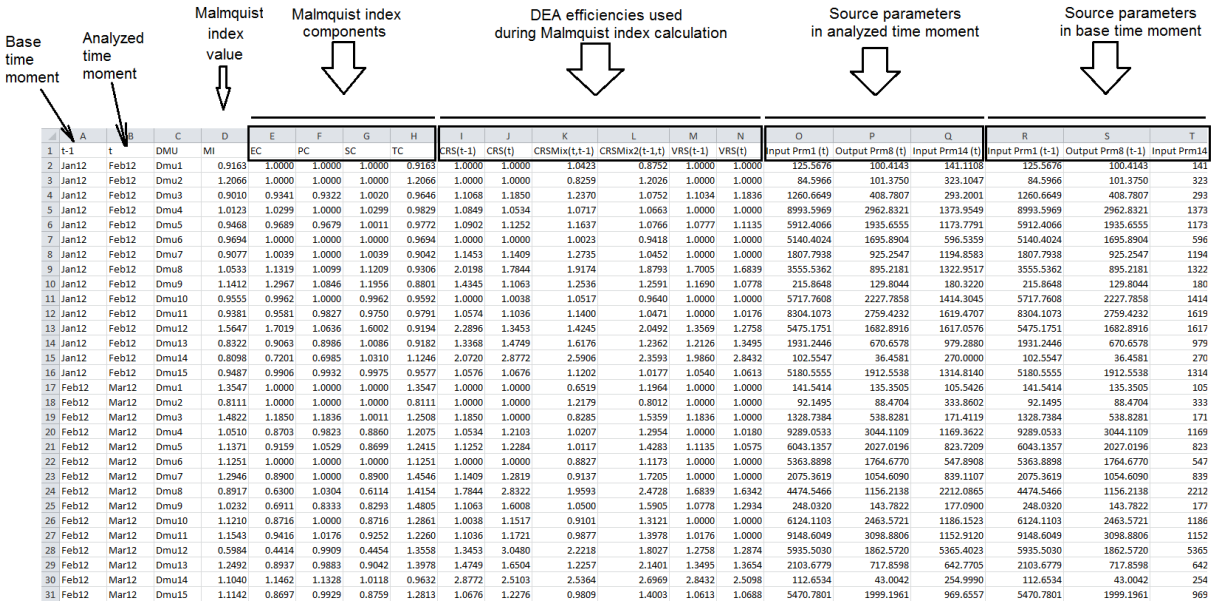


Figure 11 Rpt4_DataForRegression. Report with joined data on Malmquist index and source object parameters viewed in Notepad

3.5 Rpt5. Terms and names used in reports

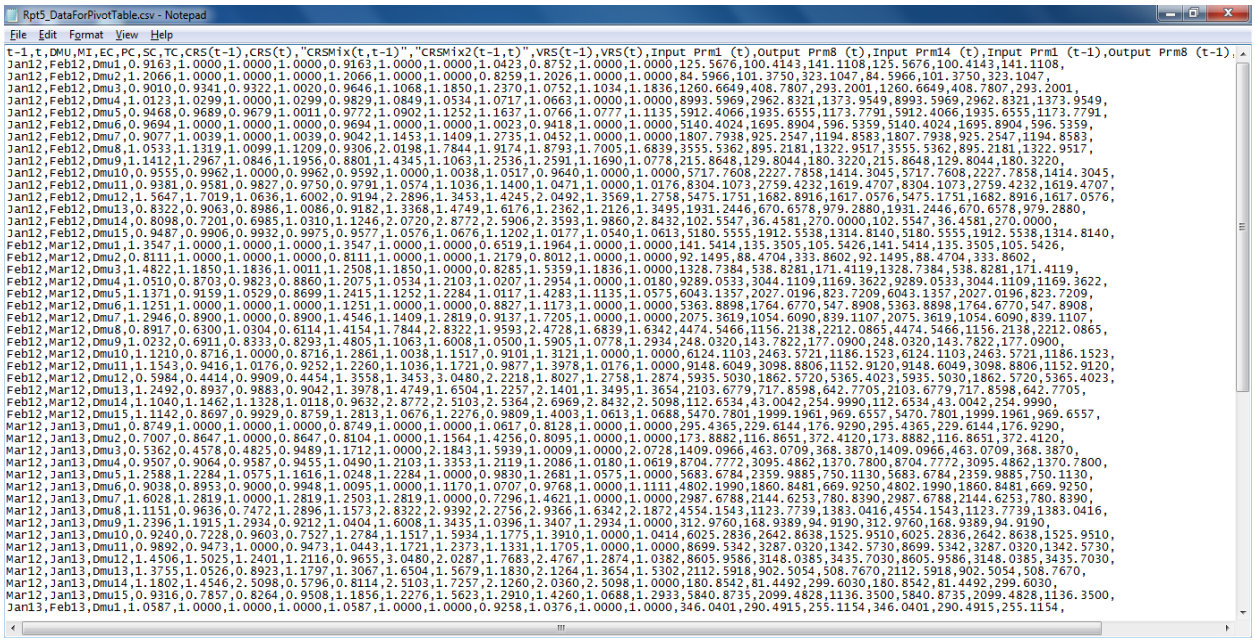
This report has name as **Rpt5_DataForPivotTable**. This report contains data about Malmquist index, its components, DEA efficiencies and object parameters. In this report, time periods information is displayed separately from object names column so that this report can be used for creating a pivot table using Microsoft Excel for your research paper.

This report is generated as a .csv file which you may study using Microsoft Excel. The contents of this report are shown on Figure 12 - Figure 13.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	t-1	t	DMU	MI	EC	PC	SC	TC	CRS(t-1)	CRS(t)	CRSMix(t,t-1)	CRSMix2(t-1,t)	VRS(t-1)	VRS(t)	Input Prm1 (t)	Output Prm8 (t)	Input Prm14 (t)	Input Prm1 (t-1)	Output Prm8 (t-1)	Input Prm14
2	Jan12	Feb12	Dmu1	0.9163	1.0000	1.0000	1.0000	0.9163	1.0000	1.0000	1.0423	0.8752	1.0000	1.0000	125.5676	100.4143	141.1108	125.5676	100.4143	141
3	Jan12	Feb12	Dmu2	1.2066	1.0000	1.0000	1.0000	1.2066	1.0000	1.0000	0.8259	1.2026	1.0000	1.0000	84.5966	101.3750	323.1047	84.5966	101.3750	323
4	Jan12	Feb12	Dmu3	0.9010	0.9341	0.9322	1.0020	0.9646	1.1068	1.1850	1.2370	1.0752	1.1034	1.1836	1260.6649	408.7807	293.2001	1260.6649	408.7807	293
5	Jan12	Feb12	Dmu4	1.0123	1.0299	1.0000	1.0299	0.9829	1.0849	1.0534	1.0717	1.0663	1.0000	1.0000	8993.5969	2962.8321	1373.9549	8993.5969	2962.8321	1373
6	Jan12	Feb12	Dmu5	0.9468	0.9689	0.9679	1.0011	0.9772	1.0902	1.1252	1.1637	1.0766	1.0777	1.1135	5912.4066	1935.6555	1173.7791	5912.4066	1935.6555	1173
7	Jan12	Feb12	Dmu6	0.9694	1.0000	1.0000	1.0000	0.9694	1.0000	1.0000	1.0023	0.9418	1.0000	1.0000	5140.4024	1695.8904	596.5359	5140.4024	1695.8904	596
8	Jan12	Feb12	Dmu7	0.9077	1.0039	1.0000	1.0039	0.9042	1.1453	1.1409	1.2735	1.0452	1.0000	1.0000	1807.7938	925.2547	1194.8583	1807.7938	925.2547	1194
9	Jan12	Feb12	Dmu8	1.0533	1.1319	1.0099	1.1209	0.9306	2.0198	1.7844	1.9174	1.8793	1.7005	1.6839	3555.5362	895.2181	1322.9517	3555.5362	895.2181	1322
10	Jan12	Feb12	Dmu9	1.1412	1.2967	1.0846	1.1956	0.8801	1.4345	1.1063	1.2536	1.2591	1.1690	1.0778	215.8648	129.8044	180.3220	215.8648	129.8044	180
11	Jan12	Feb12	Dmu10	0.9555	0.9962	1.0000	0.9962	0.9592	1.0000	1.0038	1.0517	0.9640	1.0000	1.0000	5717.7608	2227.7858	1414.3045	5717.7608	2227.7858	1414
12	Jan12	Feb12	Dmu11	0.9381	0.9581	0.9827	0.9750	0.9791	1.0574	1.1036	1.1400	1.0471	1.0000	1.0176	8304.1073	2759.4232	1619.4707	8304.1073	2759.4232	1619
13	Jan12	Feb12	Dmu12	1.5647	1.7019	1.0636	1.6002	0.9194	2.2896	1.3453	1.4245	2.0492	1.3569	1.2758	5475.1751	1682.8916	1617.0576	5475.1751	1682.8916	1617
14	Jan12	Feb12	Dmu13	0.8322	0.9063	0.8986	1.0086	0.9182	1.3368	1.4749	1.6176	1.2362	1.2126	1.3495	1931.2446	670.6578	979.2880	1931.2446	670.6578	979
15	Jan12	Feb12	Dmu14	0.8098	0.7201	0.6985	1.0310	1.1246	2.0720	2.8772	2.5906	2.3593	1.9860	2.8432	102.5547	36.4581	270.0000	102.5547	36.4581	270
16	Jan12	Feb12	Dmu15	0.9487	0.9906	0.9932	0.9975	0.9577	1.0576	1.0676	1.1202	1.0177	1.0540	1.0613	5180.5555	1912.5538	1314.8140	5180.5555	1912.5538	1314
17	Feb12	Mar12	Dmu1	1.3547	1.0000	1.0000	1.0000	1.3547	1.0000	1.0000	0.6519	1.1964	1.0000	1.0000	141.5414	135.3505	105.5426	141.5414	135.3505	105
18	Feb12	Mar12	Dmu2	0.8111	1.0000	1.0000	1.0000	0.8111	1.0000	1.0000	1.2179	0.8012	1.0000	1.0000	92.1495	88.4704	333.8602	92.1495	88.4704	333
19	Feb12	Mar12	Dmu3	1.4822	1.1850	1.1836	1.0011	1.2508	1.1850	1.0000	0.8285	1.5359	1.1836	1.0000	1328.7384	538.8281	171.4119	1328.7384	538.8281	171
20	Feb12	Mar12	Dmu4	1.0510	0.8703	0.9823	0.8860	1.2075	1.0534	1.2103	1.0207	1.2954	1.0000	1.0180	9289.0533	3044.1109	1169.3622	9289.0533	3044.1109	1169
21	Feb12	Mar12	Dmu5	1.1371	0.9159	1.0529	0.8699	1.2415	1.1252	1.2284	1.0117	1.4283	1.1135	1.0575	6043.1357	2027.0196	823.7209	6043.1357	2027.0196	823
22	Feb12	Mar12	Dmu6	1.1251	1.0000	1.0000	1.0000	1.1251	1.0000	1.0000	0.8827	1.1173	1.0000	1.0000	5363.8898	1764.6770	547.8908	5363.8898	1764.6770	547
23	Feb12	Mar12	Dmu7	1.2946	0.8900	1.0000	0.8900	1.4546	1.1409	1.2819	0.9137	1.7205	1.0000	1.0000	2075.3619	1054.6090	839.1107	2075.3619	1054.6090	839
24	Feb12	Mar12	Dmu8	0.8917	0.6300	1.0304	0.6114	1.4154	1.7844	2.8322	1.9593	2.4728	1.6839	1.6342	4474.5466	1156.2138	2212.0865	4474.5466	1156.2138	2212
25	Feb12	Mar12	Dmu9	1.0232	0.6911	0.8333	0.8293	1.4805	1.1063	1.6008	1.0500	1.5905	1.0778	1.2934	248.0320	143.7822	177.0900	248.0320	143.7822	177
26	Feb12	Mar12	Dmu10	1.1210	0.8716	1.0000	0.8716	1.2861	1.0038	1.1517	0.9101	1.3121	1.0000	1.0000	6124.1103	2463.5721	1186.1523	6124.1103	2463.5721	1186
27	Feb12	Mar12	Dmu11	1.1543	0.9416	1.0176	0.9252	1.2260	1.1036	1.1721	0.9877	1.3978	1.0176	1.0000	9148.6049	3098.8806	1152.9120	9148.6049	3098.8806	1152
28	Feb12	Mar12	Dmu12	0.5984	0.4414	0.9909	0.4454	1.3558	1.3453	3.0480	2.2218	1.8027	1.2758	1.2874	5935.5030	1862.5720	5365.4023	5935.5030	1862.5720	5365
29	Feb12	Mar12	Dmu13	1.2492	0.8937	0.9883	0.9042	1.3978	1.4749	1.6504	1.2257	2.1401	1.3495	1.3654	2103.6779	717.8598	642.7705	2103.6779	717.8598	642
30	Feb12	Mar12	Dmu14	1.1040	1.1462	1.1328	1.0118	0.9632	2.8772	2.5103	2.5364	2.6969	2.8432	2.5098	112.6534	43.0042	254.9990	112.6534	43.0042	254
31	Feb12	Mar12	Dmu15	1.1142	0.8697	0.9929	0.8759	1.2813	1.0676	1.2276	0.9809	1.4003	1.0613	1.0688	5470.7801	1999.1961	969.6557	5470.7801	1999.1961	969

Figure 12 Rpt5_DataForPivotTable. Report for pivot table preparation displayed as an Excel table



Rpt5_DataForPivotTable.csv - Notepad

File Edit Format View Help

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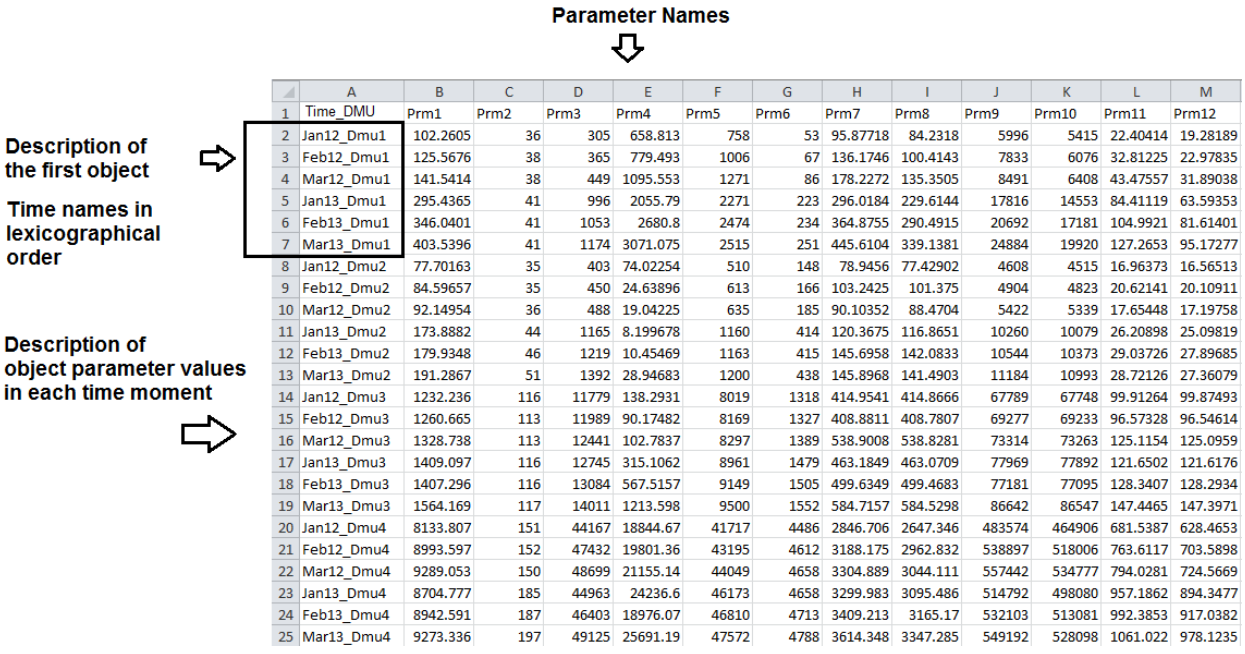
Jan12,Feb12,Dmu12,1.5647,1.7019,1.0636,1.6002,0.9194,2.2896,1.3453,1.4245,2.0492,1.3569,1.2758,5475.1751,1682.8916,1617.0576,5475.1751,1682.8916,1617.0576,
Jan12,Feb12,Dmu13,0.8322,0.9063,0.8986,1.0086,0.9182,1.3368,1.4749,1.6176,1.2362,1.2126,1.3495,1931.2446,670.6578,979.2880,1931.2446,670.6578,979.2880,
Jan12,Feb12,Dmu14,0.8098,0.7201,0.6985,1.0310,1.1246,2.0720,2.8772,2.5906,2.3593,1.9860,2.8432,102.5547,36.4581,270.0000,102.5547,36.4581,270.0000,
Jan12,Feb12,Dmu15,0.9487,0.9906,0.9932,0.9975,0.9577,1.0576,1.0676,1.1202,1.0177,1.0540,1.0613,5180.5555,1912.5538,1314.8140,5180.5555,1912.5538,1314.8140,
Feb12,Mar12,Dmu1,1.3547,1.0000,1.0000,1.0000,1.3547,1.0000,1.0000,0.6519,1.1964,1.0000,1.0000,141.5414,135.3505,105.5426,141.5414,135.3505,105.5426,
Feb12,Mar12,Dmu2,0.8111,1.0000,1.0000,1.0000,0.8111,1.0000,1.0000,1.2179,0.8012,1.0000,1.0000,92.1495,88.4704,333.8602,92.1495,88.4704,333.8602,
Feb12,Mar12,Dmu3,1.4822,1.1850,1.1836,1.0011,1.2508,1.1850,1.0000,0.8285,1.5359,1.1836,1.0000,1328.7384,538.8281,171.4119,1328.7384,538.8281,171.4119,
Feb12,Mar12,Dmu4,1.0510,0.8703,0.9823,0.8860,1.2075,1.0534,1.2103,1.0207,1.2954,1.0000,1.0180,9289.0533,3044.1109,1169.3622,9289.0533,3044.1109,1169.3622,
Feb12,Mar12,Dmu5,1.1371,0.9159,1.0529,0.8699,1.2415,1.1252,1.2284,1.0117,1.4283,1.1135,1.0575,6043.1357,2027.0196,823.7209,6043.1357,2027.0196,823.7209,
Feb12,Mar12,Dmu6,1.1251,1.0000,1.0000,1.0000,1.1251,1.0000,1.0000,0.8827,1.1173,1.0000,1.0000,5363.8898,1764.6770,547.8908,5363.8898,1764.6770,547.8908,
Feb12,Mar12,Dmu7,1.2946,0.8900,1.0000,0.8900,1.4546,1.1409,1.2819,0.9137,1.7205,1.0000,1.0000,2075.3619,1054.6090,839.1107,2075.3619,1054.6090,839.1107,
Feb12,Mar12,Dmu8,0.8917,0.6300,1.0304,0.6114,1.4154,1.7844,2.8322,1.9593,2.4728,1.6839,1.6342,4474.5466,1156.2138,2212.0865,4474.5466,1156.2138,2212.0865,
Feb12,Mar12,Dmu9,1.0232,0.6911,0.8333,0.8293,1.4805,1.1063,1.6008,1.0500,1.5905,1.0778,1.2934,248.0320,143.7822,177.0900,248.0320,143.7822,177.0900,
Feb12,Mar12,Dmu10,1.1210,0.8716,1.0000,0.8716,1.2861,1.0038,1.1517,0.9101,1.3121,1.0000,1.0000,6124.1103,2463.5721,1186.1523,6124.1103,2463.5721,1186.1523,
Feb12,Mar12,Dmu11,1.1543,0.9416,1.0176,0.9252,1.2260,1.1036,1.1721,0.9877,1.3978,1.0176,1.0000,9148.6049,3098.8806,1152.9120,9148.6049,3098.8806,1152.9120,
Feb12,Mar12,Dmu12,0.5984,0.4414,0.9909,0.4454,1.3558,1.3453,3.0480,2.2218,1.8027,1.2758,1.2874,5935.5030,1862.5720,5365.4023,5935.5030,1862.5720,5365.4023,
Feb12,Mar12,Dmu13,1.2492,0.8937,0.9883,0.9042,1.3978,1.4749,1.6504,1.2257,2.1401,1.3495,1.3654,2103.6779,717.8598,642.7705,2103.6779,717.8598,642.7705,
Feb12,Mar12,Dmu14,1.1040,1.1462,1.1328,1.0118,0.9632,2.8772,2.5103,2.5364,2.6969,2.8432,2.5098,112.6534,43.0042,254.9990,112.6534,43.0042,254.9990,
Feb12,Mar12,Dmu15,1.1142,0.8697,0.9929,0.8759,1.2813,1.0676,1.2276,0.9809,1.4003,1.0613,1.0688,5470.7801,1999.1961,969.6557,5470.7801,1999.1961,969.6557,
Mar12,Jan13,Dmu1,0.8749,1.0000,1.0000,1.0000,0.8749,1.0000,1.0000,1.0617,0.8128,1.0000,1.0000,295.4365,229.6144,176.9290,295.4365,229.6144,176.9290,
Mar12,Jan13,Dmu2,0.7007,0.8647,1.0000,0.8647,0.8104,1.0000,1.1564,1.4256,0.8095,1.0000,1.0000,173.8882,116.8651,372.4120,173.8882,116.8651,372.4120,
Mar12,Jan13,Dmu3,0.5362,0.4578,0.4825,0.9489,1.1712,1.0000,2.1843,1.5939,1.0000,1.0000,2.0728,1409.0966,463.0709,368.3870,1409.0966,463.0709,368.3870,
Mar12,Jan13,Dmu4,0.9507,0.9064,0.9587,0.9455,1.0490,1.2103,1.3353,1.2119,1.2086,1.0180,1.0619,8704.7772,3095.4862,1370.7800,8704.7772,3095.4862,1370.7800,
Mar12,Jan13,Dmu5,1.2588,1.2284,1.0575,1.1616,1.0248,1.2284,1.0000,0.9830,1.2681,1.0575,1.0000,5683.6784,2359.9885,750.1130,5683.6784,2359.9885,750.1130,
Mar12,Jan13,Dmu6,0.9038,0.8953,0.9000,0.9948,1.0095,1.0000,1.1170,1.0707,0.9768,1.0000,1.1111,4802.1990,1860.8481,669.9250,4802.1990,1860.8481,669.9250,
Mar12,Jan13,Dmu7,1.6028,1.2819,1.0000,1.2819,1.2503,1.2819,1.0000,0.7296,1.4621,1.0000,1.0000,2987.6788,2144.6253,780.8390,2987.6788,2144.6253,780.8390,
Mar12,Jan13,Dmu8,1.1151,0.9636,0.7472,1.2896,1.1573,2.8322,2.9392,2.2756,2.9366,1.6342,2.1872,4554.1543,1123.7739,1383.0416,4554.1543,1123.7739,1383.0416,
Mar12,Jan13,Dmu9,1.2396,1.1915,1.2934,0.9212,1.0404,1.6008,1.3435,1.0396,1.3407,1.2934,1.0000,312.9760,168.9389,94.9190,312.9760,168.9389,94.9190,
Mar12,Jan13,Dmu10,0.9240,0.7228,0.9603,0.7527,1.2784,1.1517,1.5934,1.1775,1.3910,1.0000,1.0414,6025.2836,2642.8638,1525.9510,6025.2836,2642.8638,1525.9510,
Mar12,Jan13,Dmu11,0.9892,0.9473,1.0000,0.9473,1.0443,1.1721,1.2373,1.1331,1.1705,1.0000,1.0000,8699.5342,3287.0320,1342.5730,8699.5342,3287.0320,1342.5730,
Mar12,Jan13,Dmu12,1.4506,1.5025,1.2401,1.2116,0.9655,3.0480,2.0287,1.7683,2.4767,1.2874,1.0382,8605.9586,3148.0385,3435.7030,8605.9586,3148.0385,3435.7030,
Mar12,Jan13,Dmu13,1.3755,1.0526,0.8923,1.1797,1.3067,1.6504,1.5679,1.1830,2.1264,1.3654,1.5302,2112.5918,902.5054,508.7670,2112.5918,902.5054,508.7670,
Mar12,Jan13,Dmu14,1.1802,1.4546,2.5098,0.5796,0.8114,2.5103,1.7257,2.1260,2.0360,2.5098,1.0000,180.8542,81.4492,299.6030,180.8542,81.4492,299.6030,
Mar12,Jan13,Dmu15,0.9316,0.7857,0.8264,0.9508,1.1856,1.2276,1.5623,1.2910,1.4260,1.0688,1.2933,5840.8735,2099.4828,1136.3500,5840.8735,2099.4828,1136.3500,
Jan13,Feb13,Dmu1,1.0587,1.0000,1.0000,1.0000,1.0587,1.0000,1.0000,0.9258,1.0376,1.0000,1.0000,346.0401,290.4915,255.1154,346.0401,290.4915,255.1154,
```

Figure 13 Rpt5_DataForPivotTable. Report for pivot table preparation viewed in Notepad

4 SOURCE DATA REQUIREMENTS

The source data for analysis in Malmquist Index Software are shown on Figure 14.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Time_DMU	Prm1	Prm2	Prm3	Prm4	Prm5	Prm6	Prm7	Prm8	Prm9	Prm10	Prm11	Prm12
2	Jan12_Dmu1	102.2605	36	305	658.813	758	53	95.87718	84.2318	5996	5415	22.40414	19.28189
3	Feb12_Dmu1	125.5676	38	365	779.493	1006	67	136.1746	100.4143	7833	6076	32.81225	22.97835
4	Mar12_Dmu1	141.5414	38	449	1095.553	1271	86	178.2272	135.3505	8491	6408	43.47557	31.89038
5	Jan13_Dmu1	295.4365	41	996	2055.79	2271	223	296.0184	229.6144	17816	14553	84.41119	63.59353
6	Feb13_Dmu1	346.0401	41	1053	2680.8	2474	234	364.8755	290.4915	20692	17181	104.9921	81.61401
7	Mar13_Dmu1	403.5396	41	1174	3071.075	2515	251	445.6104	339.1381	24884	19920	127.2653	95.17277
8	Jan12_Dmu2	77.70163	35	403	74.02254	510	148	78.9456	77.42902	4608	4515	16.96373	16.56513
9	Feb12_Dmu2	84.59657	35	450	24.63896	613	166	103.2425	101.375	4904	4823	20.62141	20.10911
10	Mar12_Dmu2	92.14954	36	488	19.04225	635	185	90.10352	88.4704	5422	5339	17.65448	17.19758
11	Jan13_Dmu2	173.8882	44	1165	8.199678	1160	414	120.3675	116.8651	10260	10079	26.20898	25.09819
12	Feb13_Dmu2	179.9348	46	1219	10.45469	1163	415	145.6958	142.0833	10544	10373	29.03726	27.89685
13	Mar13_Dmu2	191.2867	51	1392	28.94683	1200	438	145.8968	141.4903	11184	10993	28.72126	27.36079
14	Jan12_Dmu3	1232.236	116	11779	138.2931	8019	1318	414.9541	414.8666	67789	67748	99.91264	99.87493
15	Feb12_Dmu3	1260.665	113	11989	90.17482	8169	1327	408.8811	408.7807	69277	69233	96.57328	96.54614
16	Mar12_Dmu3	1328.738	113	12441	102.7837	8297	1389	538.9008	538.8281	73314	73263	125.1154	125.0959
17	Jan13_Dmu3	1409.097	116	12745	315.1062	8961	1479	463.1849	463.0709	77969	77892	121.6502	121.6176
18	Feb13_Dmu3	1407.296	116	13084	567.5157	9149	1505	499.6349	499.4683	77181	77095	128.3407	128.2934
19	Mar13_Dmu3	1564.169	117	14011	1213.598	9500	1552	584.7157	584.5298	86642	86547	147.4465	147.3971
20	Jan12_Dmu4	8133.807	151	44167	18844.67	41717	4486	2846.706	2647.346	483574	464906	681.5387	628.4653
21	Feb12_Dmu4	8993.597	152	47432	19801.36	43195	4612	3188.175	2962.832	538897	518006	763.6117	703.5898
22	Mar12_Dmu4	9289.053	150	48699	21155.14	44049	4658	3304.889	3044.111	557442	534777	794.0281	724.5669
23	Jan13_Dmu4	8704.777	185	44963	24236.6	46173	4658	3299.983	3095.486	514792	498080	957.1862	894.3477
24	Feb13_Dmu4	8942.591	187	46403	18976.07	46810	4713	3409.213	3165.17	532103	513081	992.3853	917.0382
25	Mar13_Dmu4	9273.336	197	49125	25691.19	47572	4788	3614.348	3347.285	549192	528098	1061.022	978.1235

Figure 14 Example of source data meeting all requirements

The source data should meet the following requirements:

- The first row (parameter names row) should contain names of parameters describing researched object system;
- The first column (the DMU names column) should contain names of researched objects;
- The rest table cells should contain non-zero numerical data about parameter values of researched objects. The data should correspond to the objects enumeration order in the DMU names column and parameters enumeration order in the parameter names row;
- Each table row should store data about **one** object (unit) in **one** time moment. The pair "time moment name and object name" is defined as a data item. This pair should be unique;

- For each object, data should be provided for **all** considered time periods. The time period is determined by two moments as time interval. The first time moment is called "a base moment" (the starting point of time interval). The second time moment is called "analyzed moment" (the end point of time interval);
- Name of each data item should contain the name of the time moment (the starting point OR the end point) to which the object data are related. The time moment name should stand before the object name and be separated from it with a special symbol (underscore symbol ('_') by default). An example of a proper data item name is "sep2013_DMU1" where sep2013 is time moment name and DMU1 is analyzed object name.
- To avoid errors connected to bad recognition of time moment names or object names, neither time moment names nor object names should contain the underscore symbol ('_');

  Attention! The example "sep_2013_DMU1" will cause error in object name recognition because the term "sep_2013" contains underscore symbol ('_'). Correct data item name is "sep2013_DMU1".
- The data should be sorted according to the following rules:
  - Data about the first object in all time moments should come first in source data table. After the first object, the data about the second object should be provided in a similar way etc.
  - The names of time moments should be enumerated according to their lexicographical order in terms of their names semantics (i.e. January before February, Monday before Tuesday etc.). The time moment names order should be correctly specified at least for the first object being researched.
  - The description of the first object is a template for correct recognition of other objects.

If your source data do not meet these requirements, this may lead to errors while importing data using Importer or conducting their analysis using Malmquist Index Software.

The dataset meeting all the data requirements is shown on Figure 1. In this example, the data have been provided for 4 objects (Dmu1, Dmu2, Dmu3, Dmu4) which change their parameters within 6 time moments (Jan12, Feb12, Mar12, Jan13, Feb13 and Mar13). Parameter values specified for object Dmu1 related to time period Jan12 are provided in the table row corresponding to the data item "Jan12_Dmu1".

5 SOURCE DATA PREPARATION

The KonSi - Malmquist Index Software program requires that the source data are prepared as an **.xml file** generated in the Importer utility.

To prepare your data for analysis in KonSi - Malmquist Index Software, do the following steps:

1. Make sure that your source data meet all requirements. For source data requirements, see **Section 4** or Figure 14.

2. Save the data as a .csv file. On Figure 15, you can see how to properly save your data in this format using Microsoft Excel.

3. Import the saved data file to .xml format using the Importer utility.

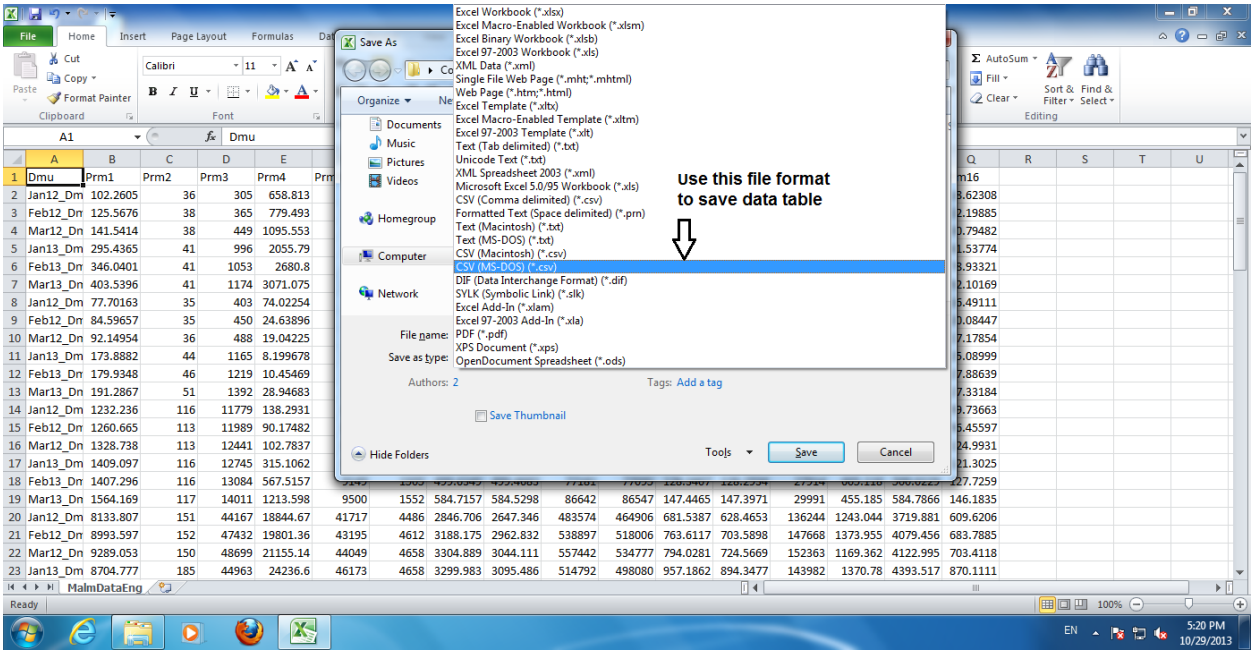


Figure 15 Example of saving source data to .csv file using Microsoft Excel

6 IMPORTER. IMPORTING SOURCE DATA

To import the data in Malmquist Index Software execute following actions.

Step 1. To launch the Importer utility, click Start, click All Programs, click KonSi – Malmquist Index Software and then click 1_Import Source Data to xml file. (Figure 16)

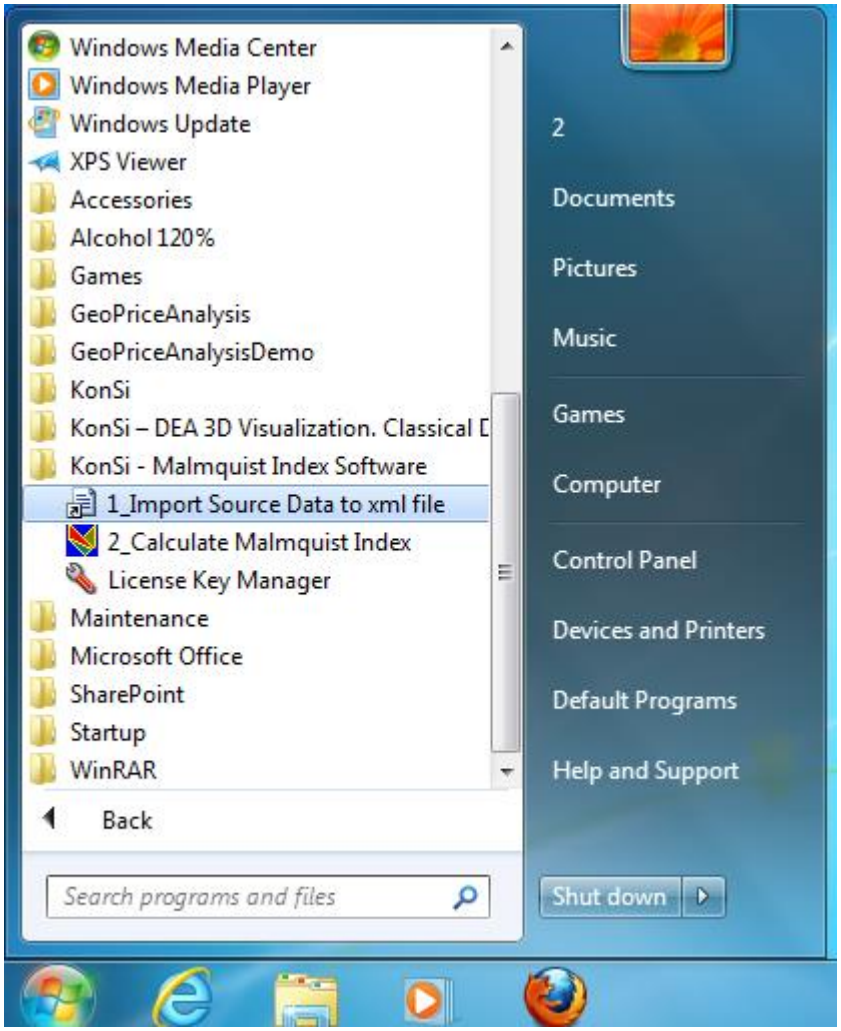


Figure 16 Launching Importer utility from the Start menu

Step 2. In the Importer utility window, click **Run Import** in the main menu or click **Import** button in the main window (Figure 17).

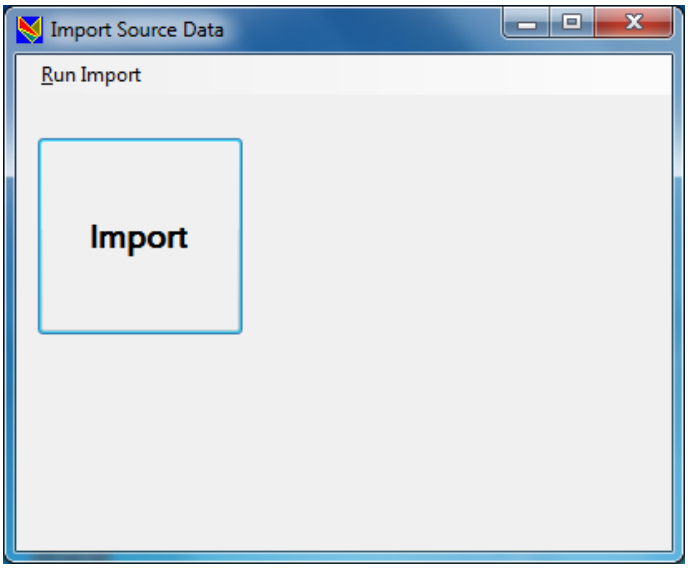


Figure 17 Launching data import wizard in the Importer utility

Step 3. In the **Import Source Data** window, click **Open** button. In the **Open** dialog box, select your source data prepared as .csv file and click **Open** (Figure 18). The preparation of source data as a .csv file is described in section 5.

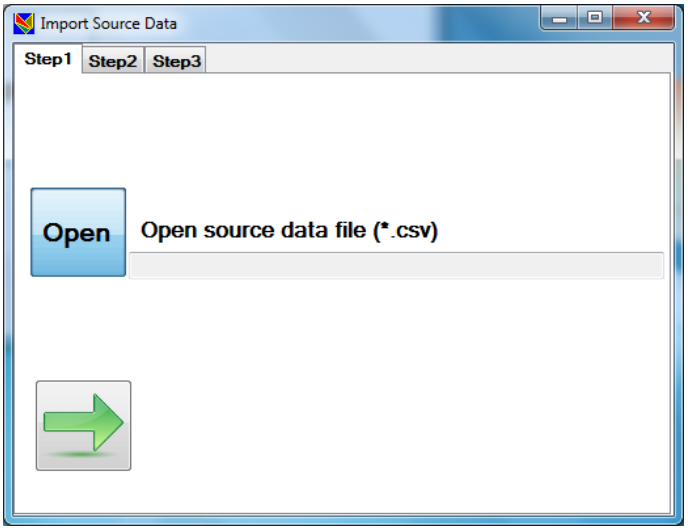


Figure 18 Opening a .csv source data file at step 1 of the data import process

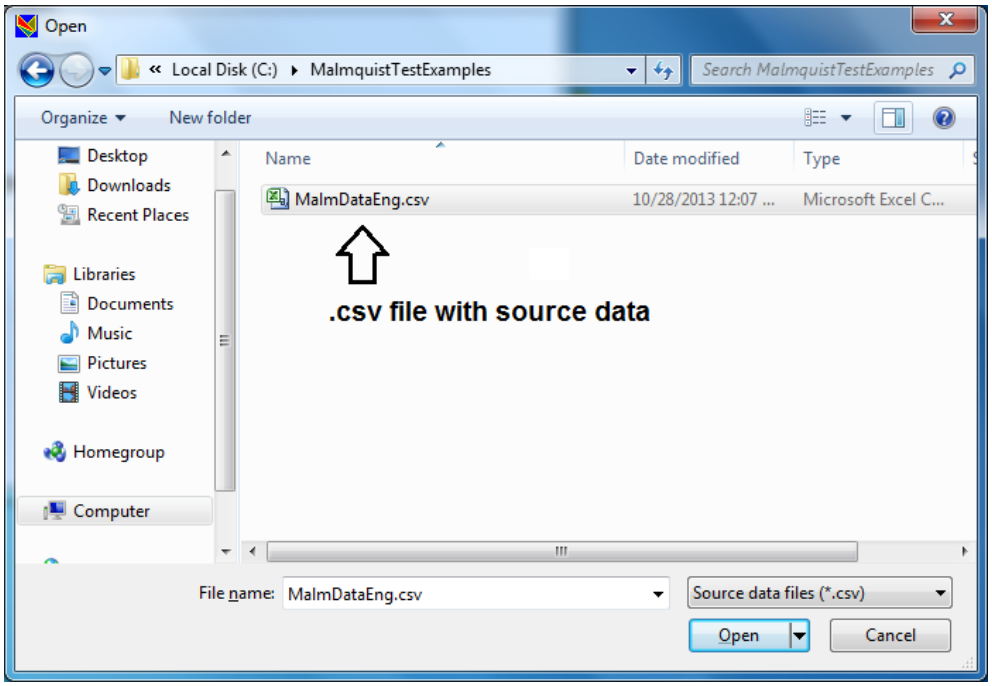


Figure 19 Selecting a source data file at step 1 of the data import process

Step 4. In the Import Source Data window, click the **Next** button (Right Arrow on Figure 18).

Step 5. Indicate where you would like to save your generated .xml file. You may do this in two ways:

If you want to save the generated .xml file in the same folder as the one containing your .csv file (by default), click Next (Right Arrow on Figure 20) to finish the process of generating the .xml file.

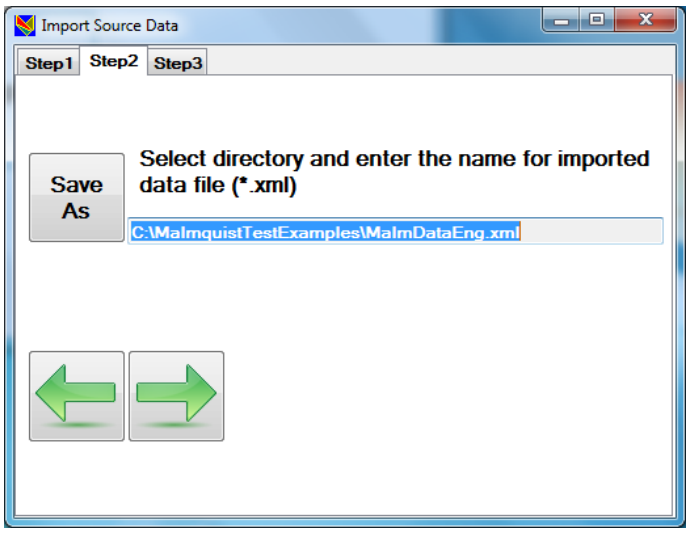


Figure 20 Saving generated .xml file under default name

If you want to save the generated .xml file in another folder and/or under another name, click **Save As**. In the Save As dialog box, define a path to your generated .xml file and enter its name in the File name box (Figure 21). Click Save and then click Next.

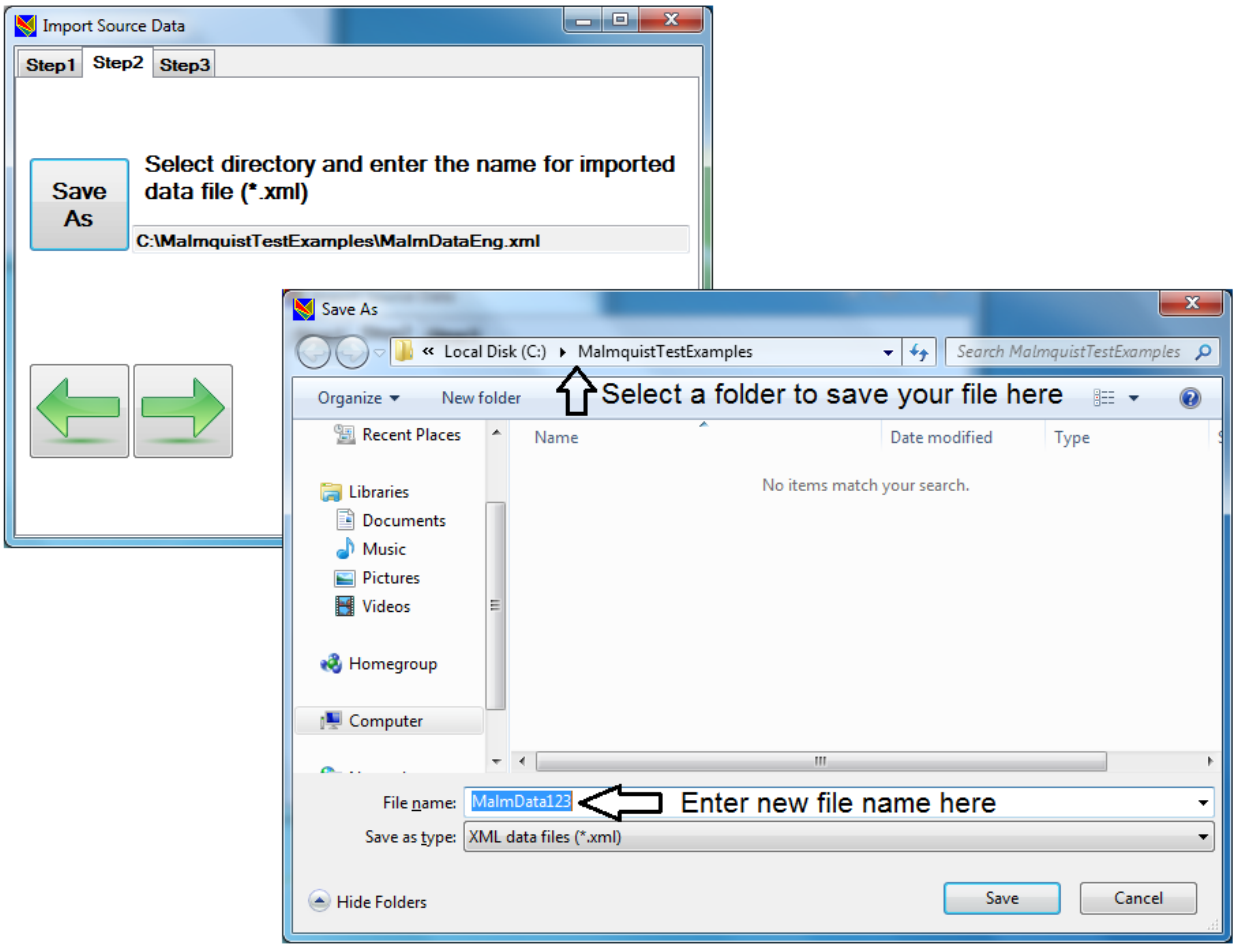


Figure 21 Saving generated .xml file under another name

Step 5. Finish import

If the .xml file is successfully saved, you see the window with the message about successful data import as shown on Figure 22. In this case, click **Finish** button with "smiling face".

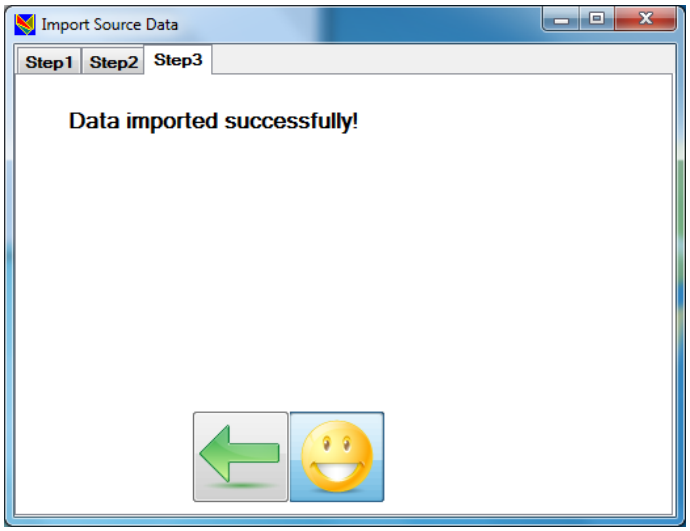


Figure 22 Message given in case of successful .xml data file generation

If the process fails, the window will contain an error message as shown on Figure 23. If you see an error message similar to the one shown on Figure 23, click the Close button ("angry face"). Close the program and correct your source data so that they meet the requirements described in Source Data Requirements section. After that, execute steps 1 – 5 again. For possible errors appearing during the import process, see Appendix "Messages Produced by .csv File Importer".

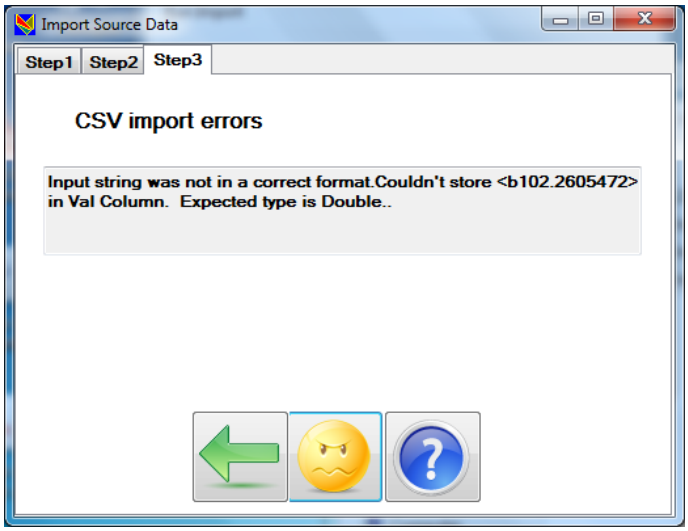


Figure 23 Error message given in case of failed .xml file generation

7 MALMQUIST INDEX CALCULATION

In this section you will learn how to process source data by using our software to calculate Malmquist Index values.

Once you create the .xml data file, you may process it using Malmquist Index Calculator. To use Malmquist Index Calculator, do the following steps:

Step 1. To launch Malmquist Index Calculator, click Start, click All Programs, click KonSi – Malmquist Index Software and then click 2_Calculate Malmquist Index (Figure 24).

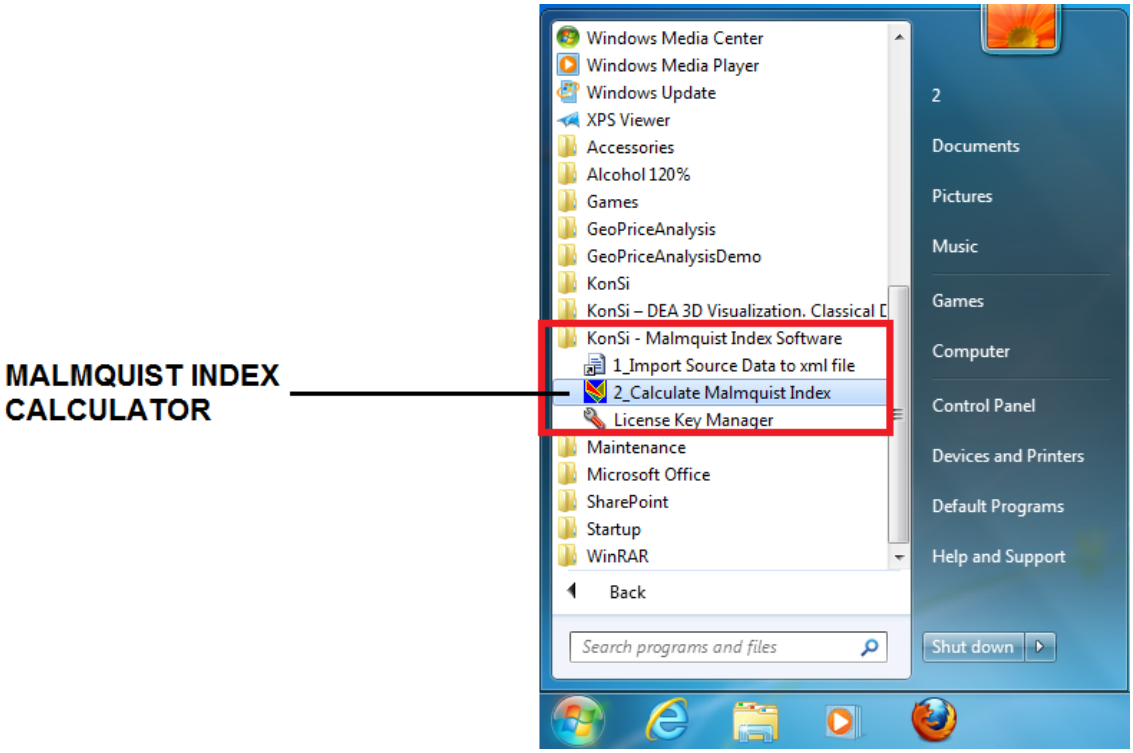


Figure 24 Launching Malmquist Index Calculator from the Start menu

Step 2. To open your .xml data file using KonSi – Malmquist Index Software, do the following steps:

1. In the main program window, click File in the menu bar. On
2. On the File menu, click Open.

3. In the Open dialog box, select your .xml data file and click Open on Figure 25. . Once you open the .xml data file, all menus in the menu bar will be enabled as shown on Figure 26.

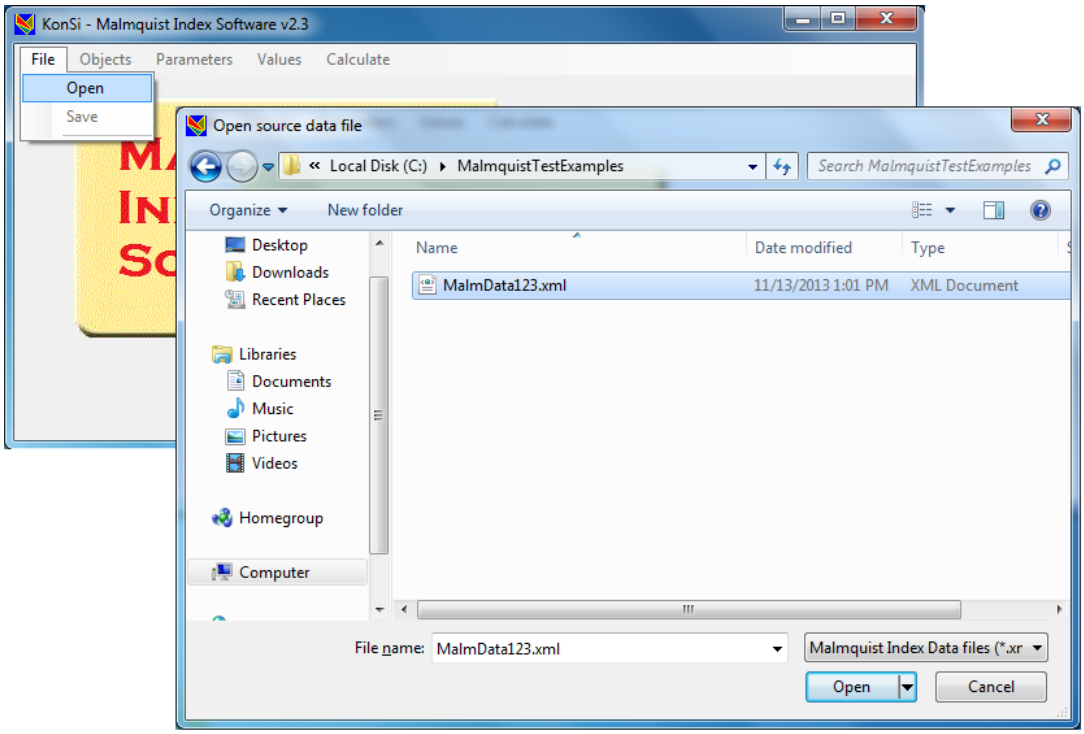


Figure 25 Opening an .xml data file using the Open command

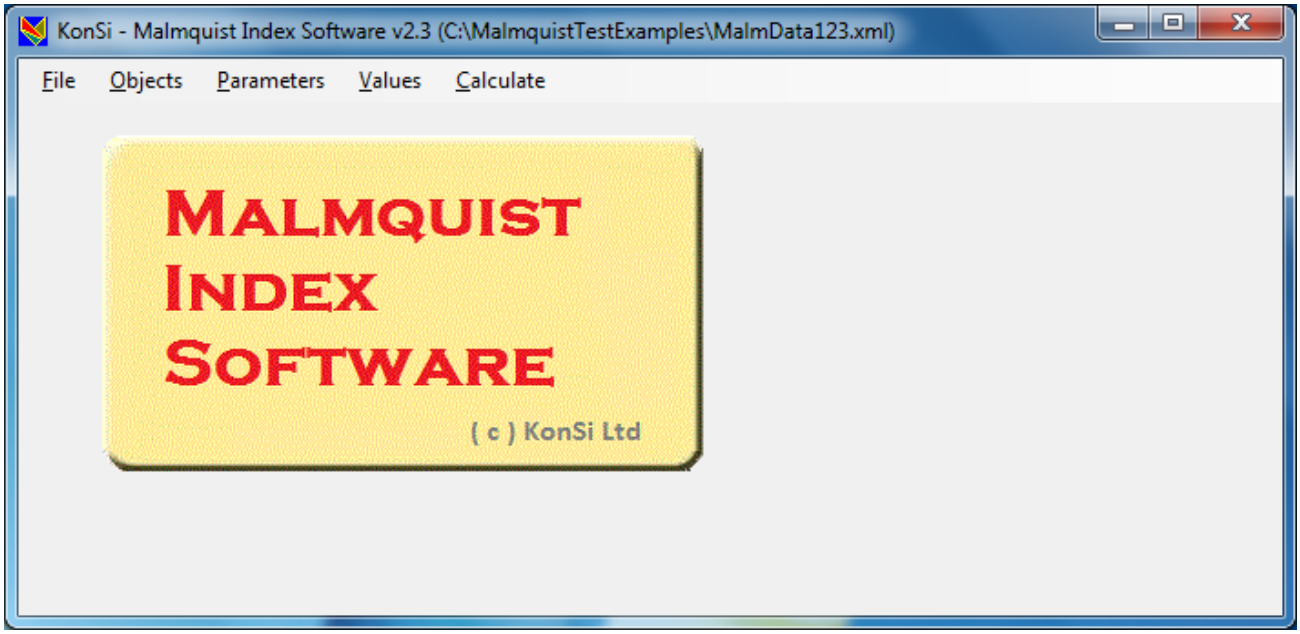


Figure 26 Main window of KonSi – Malmquist Index Software when the source data file is opened

Step 3. If you need to define data items for which the calculations should be performed, click Objects menu in the menu bar. In the Model Objects window, select necessary data items. To select a data item for calculation, select the check box next to the data item name. Remember that your data should meet all source data requirements described in Section 4.

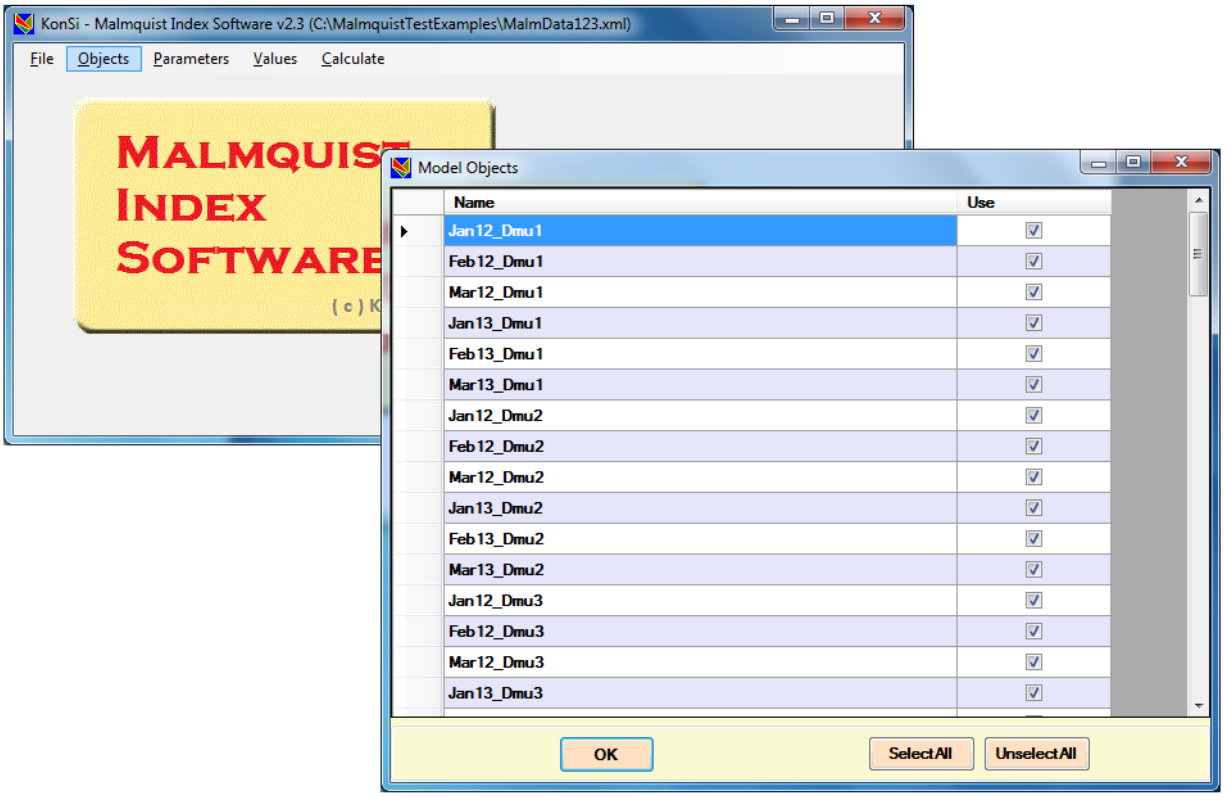


Figure 27 Select researched units

Step 4. Click Parameters in the menu bar to adjust settings of parameters which you would like to use in DEA models (Figure 28). To adjust parameter settings, do the following steps:

1. Indicate what parameters should be used during the calculation. By default, all parameters are used. To include a parameter, select the "Use Parameter" check box in the table row containing parameter name. To exclude a parameter, clear the "Use Parameter" check box in the parameters table row containing the parameter name.
2. Indicate what parameters should be considered as outputs and what ones should be considered as inputs. By default, all parameters are considered as outputs. You should have at least one input parameter. To indicate that a specific parameter should be considered as an input, clear the check box in the "Select as Output" column in the parameters table row containing the parameter name. To indicate that

the parameter is an output, select the corresponding check box in the "Select as Output" column.

3. Indicate what parameters should be considered as controlled, i.e. what parameters cannot be considered as changeable during DEA efficiency calculations. These controlled parameters have slacks. To select a parameter as controlled, select the check box in the "Select as Controlled" column next to the parameter name. If a parameter should be considered as uncontrolled, clear the corresponding check box in the "Select as Controlled" column.

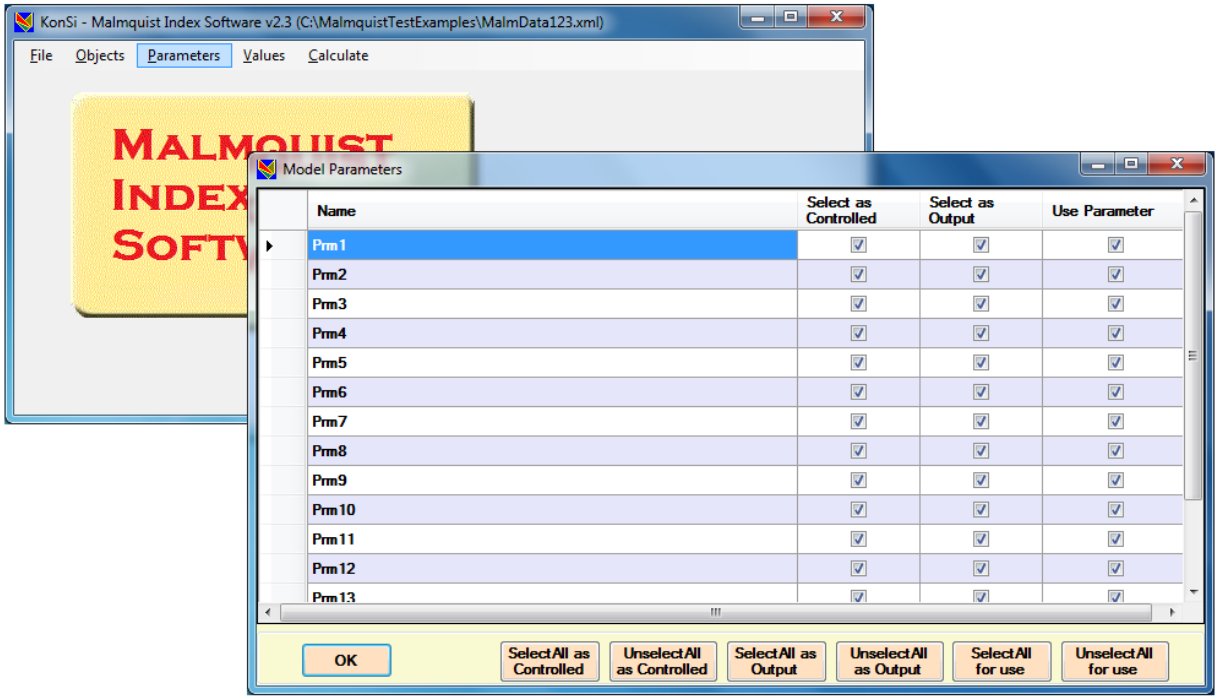


Figure 28 Define DEA model parameters for calculation of Malmquist Index

An example of parameter settings adjustment is shown on Figure 29. In this example, only 3 parameters are used in DEA models (Prm1, Prm8 and Prm14). The parameter Prm8 is defined as an output and the other two parameters (Prm1 and Prm14) are defined as inputs. All parameters are considered as controlled.

Step 5. Specify the settings of Malmquist index calculation.

In the Malmquist Index Calculation window (Figure 30), specify the following settings of Malmquist index calculation:

- Type of DEA tasks solved while calculating Malmquist index and its components (input or output oriented tasks);
- Method of Malmquist index calculation (fixed base, adjacent base, seasonal calculation).

For description of methods used by the program, see **Methods of Malmquist index calculation used by KonSi – Malmquist Index Software.**

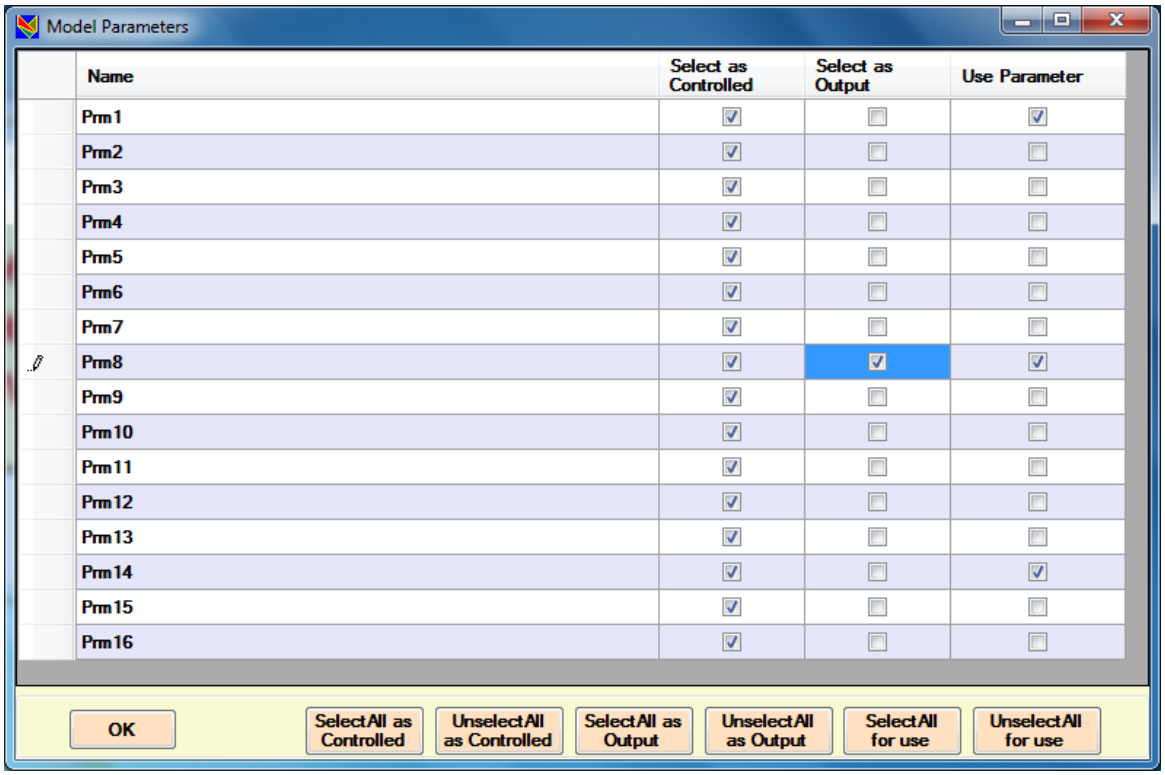


Figure 29 An example of parameter settings adjustment

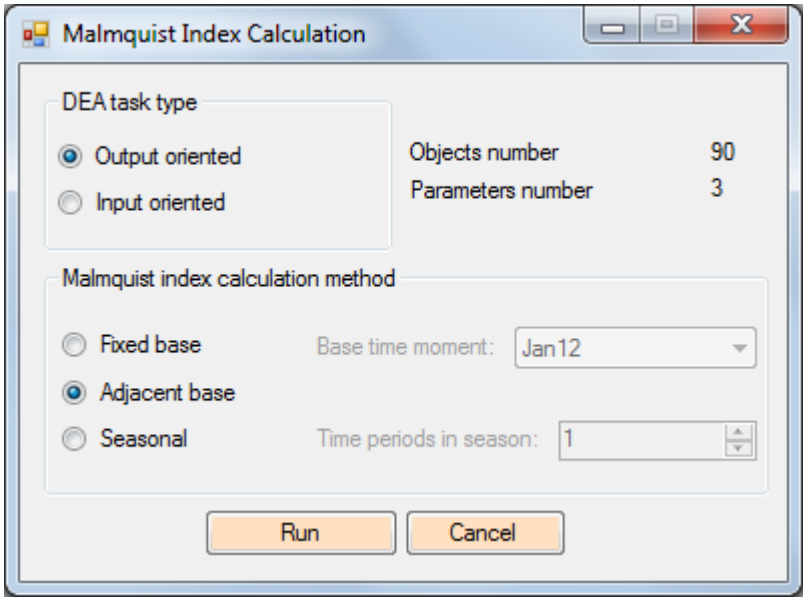


Figure 30 Malmquist Index Calculation window

If you want to use fixed-base method, click **Fixed base** and then select a moment you want to use as a base moment in the **Base time moment** box (Figure 31).

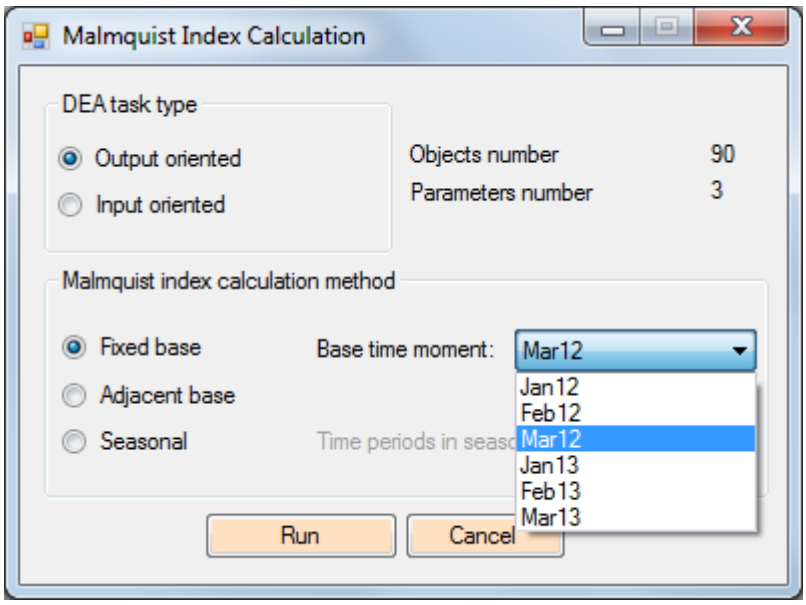


Figure 31 Selecting base time moment when using fixed-base calculation method

If you want to use adjacent-base method, click **Adjacent base**, which is set as a calculation method by default.

If you want to use seasonal calculation method, click **Seasonal** and set a value for time periods quantity in a season in the **Time periods in season** box (Figure 32).

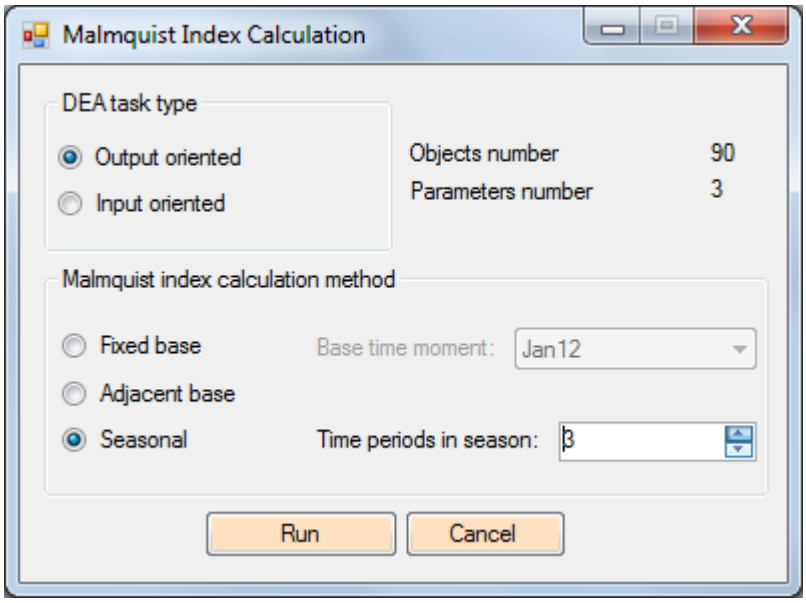


Figure 32 Selecting time periods quantity in a season when using seasonal calculation method

Step 6. Calculate Malmquist Index values. Click **Run** in the **Malmquist Index Calculation** window. After that you must save calculated reports. In the **Browse For Folder** dialog box, select a folder where you would like to save reports generated by the program and then click **OK** (Figure 33).

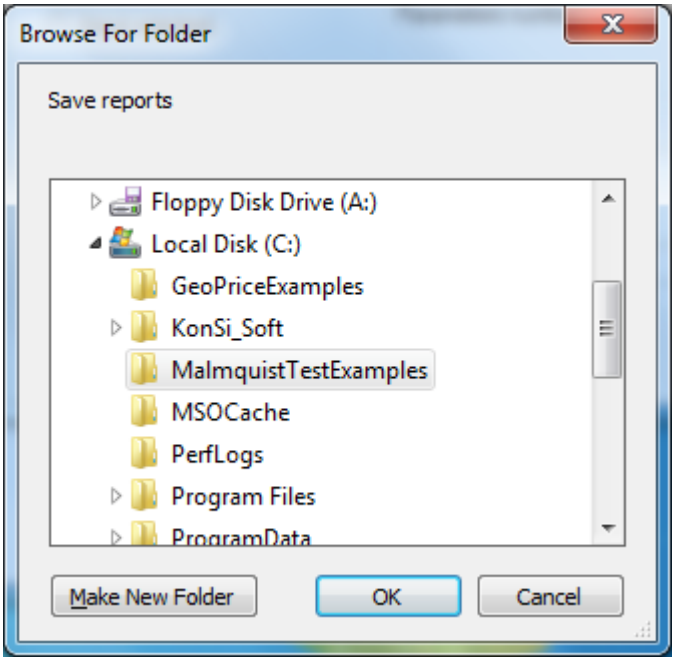


Figure 33 Select a folder where you would like to save reports

WARNING: When you generate new reports, check that all reports generated before are closed. If any of the reports generated before is already opened, the program will terminate and you will receive an error message (Figure 34).

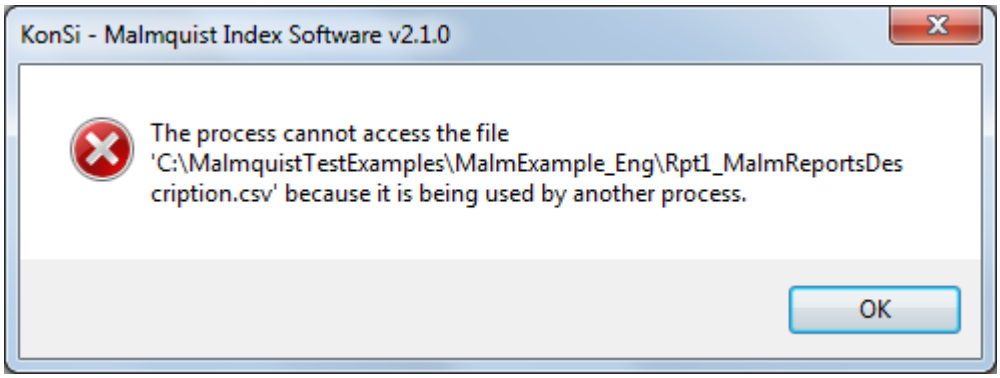


Figure 34 Error message given when any report generated before is opened

The results are saved in five .csv report files. For the description of reports generated, see **Reports generated by KonSi – Malmquist Index Software**.

8 HOW TO STUDY DEMO EXAMPLE

The data of demo example are located in the **Example** folder, which is contained in the downloaded software archive.

Files and subfolders contained in the Example folder are shown on the Figure 35

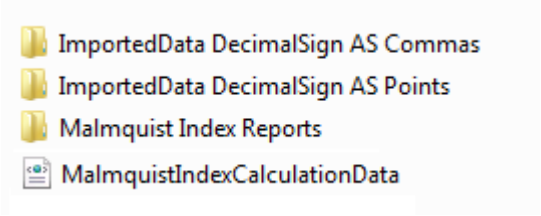


Figure 35 Folder with demo example

Source data

To study source data example, select one of the following two folders:

- ImportedData DecimalSign AS Commas
- ImportedData DecimalSign AS Points

Files in these two folders differ only by the decimal sign used in numbers (comma or point). If you use **American format settings**, select the folder with data using point as a decimal sign (the "ImportedData DecimalSign AS Points" folder).

The selected folder contains two files (Figure 36). The .xls file contains source data prepared for importing. Before starting the importing process, these data should be saved as a .csv file. The .csv file is used by the Importer utility to create an .xml file for calculating Malmquist Index.

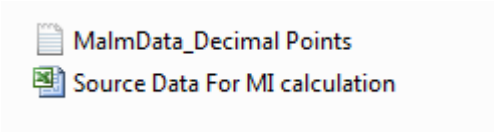


Figure 36 Examples of source data files

Studying Importer utility

To study the Importer utility, launch this utility and select the .csv file containing source data.

The Importer utility creates an .xml file for calculating Malmquist index. An example of this .xml file is stored in the **Example** folder (file named **MalmquistIndexCalculationData.xml).**

Studying Malmquist index calculation

To study the utility of Malmquist Index calculation, launch Malmquist Index Calculator and open file **MalmquistIndexCalculationData.xml.** After that, execute commands of this utility as described in Section 7.

Studying Malmquist index reports

To study the reports created by Malmquist Index Calculator, open the **MalmquistIndexReports** folder (Figure 37) . Description of these reports is given in Section 3.

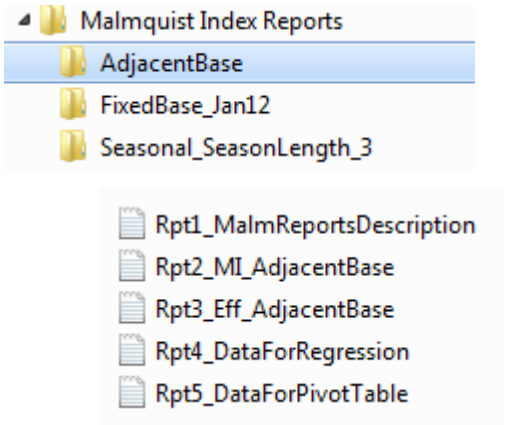


Figure 37 Folder with reports on Malmquist Index (for example, created using Adjacent Base Malmquist Index Method)

9 APPENDIX: MESSAGES PRODUCED BY CSV FILE IMPORTER

- **Data Import Errors**

  «Column 'Caption' is constrained to be unique. Value '…' is already present..»

  Reason:

  Two or more data items in your source data have equal names.

- Each table row should store data about **one** object in **one** time moment. The pair "time moment name and object name" is defined as a data item. This pair should be unique;

  Possible solution:

  Check whether there are data items with equal names in your source data. Control that **one** object is in **one** time moment.Try to correct data item names so that they become unique.

  «Column 'VarName' is constrained to be unique. Value '…' is already present..»

  Reason:

  Two or more parameters in your source data have equal names.

  Possible solution:

  Check whether there are parameters with equal names in your source data. Try to correct their names so that they become unique.

  «Value was either too large or too small for a Double. Couldn't store <…> in Val Column. Expected type is Double..»

  Reason:

  Some of your objects have parameter values larger or smaller than possible.

  Possible solution:

  Check parameter values of your model objects. They all should belong to the range [-1.79769 * (10^308), 1.79769 * (10^308)].

  «Cannot set column 'VarName'. The value violates the MaxLength limit of this column..»

  Reason:

  Some of parameters in your model have too long names.

Possible solution:

Check your model parameters given in your source data. The name length of a parameter should be less than or equal to 255 symbols. Try to shorten those names which have length more than 255 symbols. For example, you may use abbreviations.

«Cannot set column 'Caption'. The value violates the MaxLength limit of this column..»

Reason:

Some of your data items have too long names.

Possible solution:

Check your source data items with too long names. The name length of a data item should be less than or equal to 255 symbols. Try to shorten those names which have length more than 255 symbols. For example, you may use abbreviations.

«Input string was not in a correct format. Couldn't store <> in Val Column. Expected type is Double..»

Reason:

Values are not set for some parameters of your model. Values should be set for all parameters of each object.

Possible solution:

Check whether there are empty parameter values in your source data table. If they are supposed to be equal to zero, replace them to very small value , for example, 0.0001.

«Input string was not in a correct format. Couldn't store <...> in Val Column. Expected type is Double..»

Reason:

There are either infeasible symbols in your source data table, or some numbers have two or more fractional separators (decimal points).

Possible solution:

Check your source data table for infeasible symbols in the numeric data region. The only feasible symbols for typing in parameter values are digits and the fractional separator („." by default).

REMARK:

If it is necessary for you that some parameters or objects of your model have names including a comma, which is the separator of table columns in CSV files by default, then you should enter such names in quotation marks (eg. „ "Sales, output 2" "). Otherwise, the data after the comma will be recognized by the program as belonging to another column and you may get an error "Input string was not in a correct format."

NOTE: You do not have to use quotation marks if you use Excel for editing CSV files.

«Error while opening CSV file. Object reference not set to an instance of an object..»

Reason:

There could be a backslash symbol ("\") in your source data table.

Possible solution:

- Check your source data table for a backslash symbol ("\"). If you find it, delete it and try again.