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MEASURING PERFORMANCE OF KINDERGARTENS IN MACEDONIA WITH DATA ENVELOPMENT ANALYSIS-DEA[12]

By Marjan Nikolov, MSc

President of CEA and Professor at Faculty of Business and Economics, marjan@cea.org.mk

Abstract

The process of decentralization in Macedonia started on July 1st 2005. One year is not enough to do an all encompassing evaluation of the process but a low cost monitoring can follow the changes, lower the cost of future evaluation and give some insights related to performance measurement of the transferred competencies to LGU level, fiscal gap, vertical and horizontal equalization etc. We consider the child care transfers of competency from central to local level and try to measure the efficiency and productivity of this public sector by using the nonparametric DEA method.[13]

Key words: Decentralization, performance measurement, kindergartens, intergovernmental transfers, benchmarking.

Introduction

The process of decentralization in Macedonia started on the 1st of July 2005 with the provisions of the Law on financing Local Self-Government-LSG being on power. The Law on LSG also regulates the competencies of the local governments in Macedonia. A wide range of responsibilities are listed in the provisions of Article 22 of the Law on LSG, one of which is the protection of children - Kindergartens as transferred responsibility from the Ministry of Labor and Social Policy to the LSG level.

Related to the protection of children, the following were transferred to LSG level: decision-making authority, right of ownership, staff, equipment, archives and documentations. In the first phase of the process of decentralization the financing was through the instrument of earmarked grants to cover the operational expenditures such as communal services, heating, transport, communication, materials and repair tools, and maintenance. Salaries and capital expenditures are still at central level responsibility.

In this paper we are interested to analyze the efficiency of the Macedonian kindergartens in spending the earmarked grants given the output they produce and to provide intra-industry and intra-LSG benchmarking. Of course that the measurement and data problems are evident but we put attempt to provide a cross kindergartens and cross LSG comparison with this microeconomic exercise. The main purpose of this paper is two fold. One is to promote and motivate introduction of a performance measurement system in general and two to serve as an invitation for a debate about possible performance measurement system at the LSG level for the child protection competency.

The paper is organized as follows. First, we describe the kindergartens and the possible performance measurement system and then the data for the estimation. The discussion follows after the results from the non parametric estimation are illustrated. In the annex we introduce the methodology DEA for estimating the productivity and efficiency in spending the earmarked grants across kindergartens and across LSG.

12) This paper was received for review on 28 September 2006.

13) I am using the DEA Computer Program Version 2.1 developed by Tim Coelli in 1996.

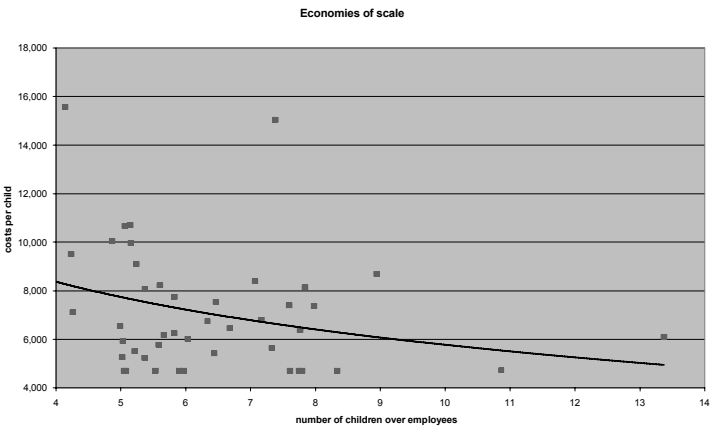
Kindergartens in Macedonia

In Macedonia, 40 municipalities have 51 public kindergartens with 20,236 registered children as of September 2005.

Box. Discussion about the kindergartens as a public production sector

Related to the input/output distinction of the production sector (see Annex 1), when there are constant returns to scale it doesn't matter if the research is input or output orientated, but it matters when there are variable returns to scale. The discussion can be extended with our problem observation of the kindergartens. Namely, there are indications of the possible returns to scale in this public sector (see the next Figure 4) and second, since it is a public sector it can be analyzed within the framework of an input oriented efficiency measure. This is because the number of children served is determined by the demand side and not from the operator side of this public sector. Because of that, the operator is constrained to look forward for improved efficiency in utilization of input quantities.

Figure 4
Efficiency at kindergartens



The data analyses show that there is no correlation between costs per employee and cost per child. However, there does seem to be some connection between the number of children per employee and the total cost per child. Kindergartens with most children per employee tend to have the lowest unit costs. Figure 4 shows that the cost per child decreases the higher the number of children per employee which might be evidence of returns to scale in this industry. In other words, differences in efficiency seem to be the most important factor in explaining cost variations between kindergartens in Macedonia.

Performance measurement at kindergartens

The implicit assumption of the process of decentralization is providing better services to the citizens. The meaning of 'better' is defined with the standards stipulated in the legislation. A performance measurement system provides decision-makers with information, which can be used to make better decisions for better services and thus, provide feedback for potential improvements in the standards i.e. improvements in the legislation.

Performance measurement can lead to important outcomes:

- Improving allocative efficiency (by guiding decision-makers in providing funds for sectors of specific local importance or selecting that mix of inputs which produce a given quantity of output at minimum cost)
- Improving technical efficiency (by helping to ensure that allocated resources translate into efficient delivery of public goods and services or producing the maximum output attainable from the given set of inputs)
- Improving transparency and accountability (by regularly informing the public on the spending of public funds and through measurement of the achieved results)
- Improving the scope of work for public staff through its citizen focus (by concentrating and directing the work of the public staff on specific objectives)

Performance measurement is based on indicators that provide quantitative and qualitative details to objectives and must be statements about the situation that should prevail when an objective is reached. The following types of indicators can be used in the kindergartens within a perfect statistical information system:

Input indicators:

- Number of children - based on age, gender and ethnicity
- Size of kindergarten (m2/child)
- Number of support staff (non-teachers) to teachers (%)
- Teachers' qualification/educational background
- Average age of buildings
- Average age of (specified) equipment
- Total funding - based on sources
- Funding per child - for each source
- Cost per class
- Cost per child per week
- Maintenance costs per square meter

Process indicators:

- Average number of children per class/group
- Occupancy rate (actual number of children relative to capacity)
- Children-teacher/staff ratio
- Opening period (number of weeks per year)
- Opening time (number of hours per day)
- Number of accidents among children
- Number of formal complaints
- Number of staff-parent meetings

Output indicators:

- Waiting time
- Children who stayed all year

Impact indicators:

- Success at primary school

The data

It takes time to establish a firm performance measurement system and a one doesn't exist yet in Macedonia for monitoring and possible evaluation of the kindergartens sector and that is why for our research purposes the following data are considered for the DEA analyses:

Inputs:

- Earmarked grants (for 2006) per employees (as of 2004)

Outputs:

- Earmarked grants (for 2006) per number of children (as of 2005 September)

No data were available for employees at:

LSG	Kindergarten
Butel	11 Oktomvri
Mak Brod	7 September
Sveti Nikole	Rahilka Goneva
Kavadarci	Rada Poceva

We use the variable returns to scale because of economies of scale indication related to the number of employees as it was shown in the figure 4.

Results from the DEA Computer Program Version 2.1

We analyze the intra-industry efficiency and intra-LSG efficiency by looking at the efficiency scores from running the DEA software. In the next Table 1 and Table 2 the efficiency scores are illustrated for the DMU kindergartens and DMU-LSG respectively. We look at the constant technical returns to scale-CRS, variable technical returns to scale-VRS and pure scale efficiency-SCALE. After that we will try to compare the pure scale efficiency with the defined input (input orientation as discussed in Box 1).

Table 1. Intra-industry efficiency benchmarking (efficiency increase from 0 to 1; irs-increasing returns to scale and drs-decreasing returns to scale)

		CRS	VRS	SCALE	
Kindergarten	**DMU**	**CRS**	**VRS**	**SCALE**	
Dimce Mircev	1	0.041	0.066	0.632	irs
Detska Radost	2	0.043	0.068	0.632	irs
Olga Miceska	3	0.095	0.100	0.944	irs
2 September	4	0.086	0.086	1.000	-
Gonca Tufa	5	0.058	0.073	0.795	irs
Femo Kulakov	6	0.195	0.282	0.693	irs
Veseli Cvetovi	7	0.583	0.696	0.838	irs
EO Mara	8	0.036	0.057	0.632	irs
Rosica	9	0.061	0.115	0.527	irs
23 August	10	0.017	0.033	0.527	irs
Aco Karamanov	11	0.018	0.044	0.422	irs
Mladost	12	0.049	0.059	0.838	irs
Breshia	13	0.018	0.044	0.422	irs
Kalinka	14	0.046	0.055	0.838	irs
VC Trena	15	0.031	0.039	0.795	irs
Goce Delcev	16	0.031	0.060	0.527	irs
11 September	17	0.280	0.352	0.795	irs
R J Korcagin	18	0.065	0.123	0.527	irs
Carka Andreevska	19	0.284	0.380	0.747	irs
Majski Cvet	20	0.018	0.044	0.422	irs
Bambi Mak	21	0.021	0.039	0.527	irs
Raspeana Mladost	22	0.119	0.159	0.747	irs
13 November	23	0.101	0.160	0.632	irs
Koco Racin	24	0.077	0.122	0.632	irs
Majski	25	0.030	0.044	0.693	irs
Buba Mara	26	0.018	0.044	0.422	irs
Angel Sajce	27	0.018	0.044	0.422	irs
Goce Delcev	28	0.632	1.000	0.632	irs
8 March	29	0.026	0.041	0.632	irs
Detska Radost	30	0.038	0.072	0.527	irs
7 September	31	0.041	0.060	0.693	irs
Jasna Risteska	32	0.043	0.068	0.632	irs
Snezana	33	0.067	0.089	0.747	irs
Veseli Cvetovi	34	0.024	0.038	0.632	irs
Nasa Idnina	35	0.025	0.047	0.527	irs
8 Mart	36	1.000	1.000	1.000	-
Pavlina Veljanova	37	0.057	0.082	0.693	irs
Detska Radost	38	0.018	0.044	0.422	irs
25 Maj	39	0.018	0.044	0.422	irs
Astibo	40	0.050	0.079	0.632	irs
Orce Nikolov	41	0.018	0.044	0.422	irs
Detska Radost	42	0.181	0.243	0.747	irs
Bratstvo-Edinstvo	43	0.062	0.089	0.693	irs
IR Lola	44	0.018	0.044	0.422	irs
K Pop-Ristov Delcev	45	0.037	0.050	0.747	irs
Srnicka	46	0.018	0.043	0.422	irs
Prolet	47	0.158	0.250	0.632	irs
Industry scores	**mean**	**0.106**	**0.145**	**0.636**	

Source: DEA scores from running the DEA software. Instruction file defined by the author.

In the next Figure 5 we illustrate the dependence of the scale efficiency of the input defined as EMG per employees in the sector.

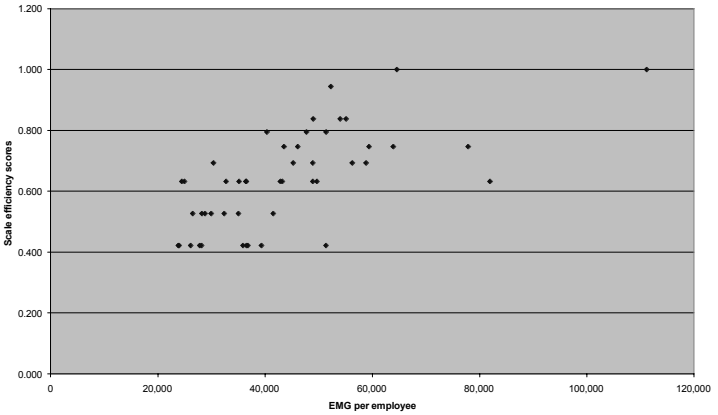


Figure 5
Returns to scale not exhausted yet in the kindergartens sector

From Figure 5 we can see that there is some correlation between the scale efficiency and the inputs measured as EMG per employee in the sector.

Similar discussion and findings are illustrated for the LSG level as well and presented in the next Table 2 and Figure 6.

Table 2. Intra-LSG efficiency benchmarking (efficiency increase from 0 to 1; irs-increasing returns to scale and drs-decreasing returns to scale)

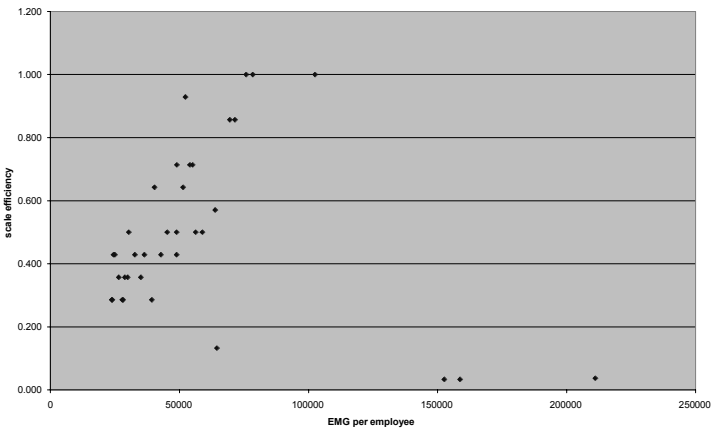
LSG	DMU	CRS	VRS	SCALE	
Veles	1	0.011	0.025	0.429	irs
Gostivar	2	0.011	0.026	0.429	irs
Kicevo	3	0.025	0.027	0.929	irs
Demir Hisar	4	0.022	0.169	0.133	drs
Krusevo	5	0.015	0.024	0.643	irs
Negotino	6	0.051	0.103	0.500	irs
Kisela Voda	7	0.153	0.214	0.714	irs
Bitola	8	0.009	0.022	0.429	irs
Gorce Petrov	9	0.016	0.045	0.357	irs
Berovo	10	0.005	0.013	0.357	irs
Radovis	11	0.005	0.017	0.286	irs
Tetovo	12	0.013	0.018	0.714	irs
Debar	13	0.005	0.017	0.286	irs
Valandovo	14	0.012	0.017	0.714	irs
Stip	15	0.008	0.013	0.643	irs
Vinica	16	0.008	0.023	0.357	irs
Resen	17	0.034	0.034	1.000	-
Kratovo	18	0.013	0.015	0.857	irs
Mak Kamanica	19	1.000	1.000	1.000	-
Centar	20	0.023	0.027	0.857	irs
Karpos	21	0.008	0.016	0.500	irs
Aerodrom	22	0.005	0.017	0.286	irs
Kumanovo	23	0.005	0.017	0.286	irs
Probistip	24	0.166	0.387	0.429	irs
Struga	25	0.007	0.016	0.429	irs

Sturmica	26	0.010	0.028	0.357	irs
Pehcevo	27	0.011	0.022	0.500	irs
Ohrid	28	0.014	0.014	1.000	-
Delcevo	29	0.006	0.015	0.429	irs
Prilep	30	0.024	0.736	0.033	drs
Kocani	31	0.015	0.030	0.500	irs
Gevgelija	32	0.033	1.000	0.033	drs
Gazi Baba	33	0.048	0.083	0.571	irs
Cair	34	0.016	0.033	0.500	irs
Kriva Palanka	35	0.005	0.017	0.286	irs
Bogdanci	36	0.030	0.797	0.037	drs
	mean	0.051	0.141	0.495	

Source: DEA scores from running the DEA software. Instruction file defined by the author.

Our indication of scale economies (returns to scale) are confirmed with the results from Table 2 as well. Namely, in the next Figure 6 we can see that the more EMG per employee the more efficient the DEA scores for the LSG units (except for the few outliers).

Figure 6
Returns to scale not exhausted yet in the kindergartens sector at LSG level



There is thus, increasing returns to scale indication in this sector (except for Prilep, Gevgelija and Bogdanci that are with decreasing economies of scale) and the scale economies are not yet exhausted if we measure the efficiency from the input side as EMG per employee. Of course that we must look at the structure of employees and all other categories of variables in order to check the robustness of our results, but we hope that this work can trigger a new way of thinking at LSG and central government about performance measurement within the process of decentralization with no ambition at this stage to provide an all encompassing study.

Conclusion

As a conclusion we can say that it is important to emphasize that decentralization is a process that will take time to complete. Such a complex operation will require monitoring and evaluation at many stages. These tools can and must be used for gaining insights into whether the goals and objectives are achieved

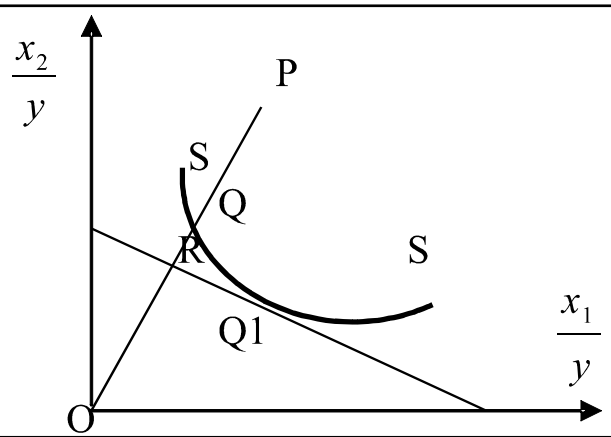
and how efficient are the resources used in the process. Of course that in order to achieve that a statistical information system in place is required, know how and willpower to conduct a complex performance reviewing. The final goal of such an operation should be a satisfied citizen and improved services at LSG level.

The goal of this paper is to motivate a debate about the decentralization process and how it can be monitored and evaluated. A possible measurement system is presented by utilizing the microeconomic theory and its application. Benchmarking provided by the DEA scores can be a powerful tool for motivating LSG administration on one side and on the other side a transparent tool for the citizen to ask for more efficiency at their yard by comparing the performance with other LSG. We illustrate some indication of possible increasing returns to scale at kindergarten industry in Macedonia but the robustness of the results should be checked in future. The methodology used is universal and can be extended to other LSG competencies as well as to other industries.

Annex 1. DEA methodology

As efficiency measurement we will use frontiers[14] or more precisely the mathematical programming frontier. The mathematical programming frontier i.e. the non-parametric method is the Data Envelopment Analysis-DEA method[15]. We'll only look at some concepts that are of substantial value for understanding the mechanism of the estimations provided in this paper. For more thorough explanation we provide references. Farrell (1957) proposed that the efficiency of a firm[16] consist of two components, the technical and the allocative efficiency. These two measures combined will provide the measure of the economic (total) efficiency. What we can see from Figure 1 is a DMU that uses two inputs x1, x2 and produces one output-y. The isoquant S-S in Figure 1 is of a fully efficient DMU. There is a production frontier that corresponds with this isoquant and is for fully efficient firms only. But, in practice we don't know the production frontier and it must be estimated from observations on a sample of firms. The estimation can be by parametric or non-parametric methods.

Figure 1



So, if the firm is operating inefficiently, say in the point-P from Figure 1, the measure of technical inefficiency could be represented by the distance-QP. This distance is representing the amount by which the inputs can be reduced without reducing the output. The percentage term by which all inputs need to be reduced to achieve technical efficient production is represented by QP/OP ratio. The technical efficiency from

14) A production function is a frontier as well. The difference is that the assumption of efficient firms in the production function method operating on frontier is relaxed with the DEA method.

15) For more in depth rationale of the method see [1], [2], and [3].

16) In a frontier analyses literature usually the firms, operators etc. are named as a Decision Making Units-DMU.

Figure 1 is thus:

$$TE = OQ / OP = 1 - QP / OP \quad (1)$$

It is obvious that-TE will take value between 0 and 1 and can be indicator for the degree of technical inefficiency of a DMU. For example, a DMU that operates at point-Q is fully efficient and the proper TE takes value 1. The allocative efficiency of a DMU that operates at point-P is:

$$AE = OR / OQ \quad (2)$$

What we can see as well from Figure 1 and from Equation 2 is that the point Q is technically efficient but allocatively inefficient. It takes the DMU to reduce its production costs to be operational at the totally efficient point- . Thus, the allocative efficiency is:

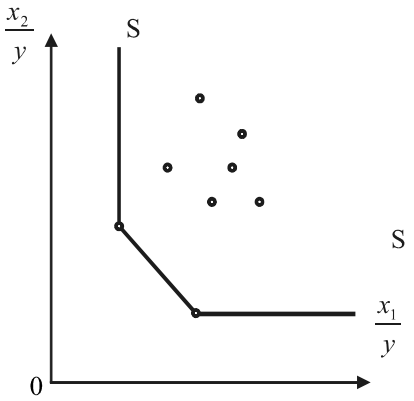
$$AE = OR / OQ \quad (3)$$

The distance-RQ represents the reduction in the production costs that would occur if the production were performing at the technically and allocatively efficient point instead at the technically efficient but allocatively inefficient point Q. Thus, the total economic efficiency will be:

$$EE = OR / OP = TE \cdot AE = OQ / OP \cdot OR / OQ \quad (4)$$

As we said previously, the production function and the proper isoquant should be estimated, because we don't know them in practice. Farell (1957) suggested an estimation of linear convex isoquant such that no point from the observed data lies to the left or below it. As an illustration for a linear convex isoquant see the next Figure 2. Later, in 1978, Charnes Cooper and Rhodes used the Farell method and the term DEA was first used by them. A mathematical programming model was used to estimate the linear convex isoquant as in Figure 2.[17]

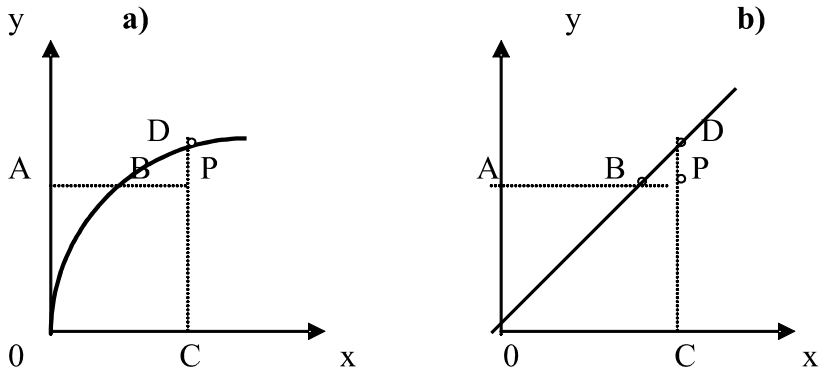
Figure 2



17) More on the construction of the DEA models see [1] and [2].

The returns to scale in connection to the input/output orientation are illustrated in the next Figure 3.

Figure 3



From Figure 3-graph a) we can see the decreasing returns to scale case and the constant returns to scale on the graph b). If we ask by how much the input quantities can be proportionally reduced so the output will be the same then this is the movement from P to B in both graphs. That is the input orientated efficiency measure. Now, if we ask by how much the output can be proportionally expanded by using the same input quantities, then this will be the movement from P to D in both graphs. What is different in both graphs is that the input/output distinction matters only in the graph a), because the BP distance is not the same as the distance PD as it is the case in the graph b).

When a technology is analyzed as variable returns to scale and constant returns to scale separately then the technical efficiency can be decomposed on scale efficiency and pure technical efficiency (see Coelli 1996):

$$TE = SE \cdot PE \quad (5)$$

References

Antonio Giuffrida and Hugh Gravelle (1999) "Measuring Performance in Primary Care: Econometric Analysis and DEA" The University of York discussion papers.

Baltagi Badi (1995) "Econometric analysis of panel data", John Wiley & Sons Ltd.

CEA (forthcoming) "Country report Macedonia LSG borrowing", LGI/OSI sponsored project.

Chambers Robert G. (1997) "Applied Production Analysis: the Dual Approach", Cambridge University Press, 5th reprint.

Charnes Abraham, William W. Cooper, Arie Y. Lewin, Lawrence M. Seiford "DEA: Theory, Methodology and Application", Kluwer Academic Publishers.

Charnes, Cooper, Divine, Ruefli, Thomas (1989) "Comparison of DEA and existing ratio and regression systems for efficiency evaluations of regulated electric cooperatives in Texas", Research in Governmental and Non-profit Accounting, Vol. 5, pp. 187-210.

Coelli Tim (1996) "A guide to DEAP Version 2.1: A DEA computer program", Centre for efficiency and productivity, University of New England, CEPA working paper 08.

Coelli Tim, D. S. Prasada Rao, George E. Battese (1998) "An introduction to efficiency and productivity analysis", Kluwer Academic Publishers.

Martin A. Rossi and Christian A. Ruzzier "On the regulatory application of efficiency measures" CEER and UADE.

Nikolov Marjan (2004) "Fiscal decentralization in Macedonia: Recent developments and challenges" WBI sponsored report for the conference in Sarajevo.

Nikolov Marjan (2005) "Focal points for local governance in Macedonia" UNDP Bratislava and GSU Atlanta sponsored country report.

Nikolov Marjan (2005) "Calculation of cost of transferred competencies and EMG" EAR TA to the Ministry of finance for fiscal decentralization.

Nikolov Marjan (2006) "Review of fiscal decentralization process in Macedonia" EAR TA for implementation and coordination of the process of decentralization in Macedonia - phase II.