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Towards a set of composite indicators on Flexicurity: The Composite indicator on Active Labour Market Policies

Massimiliano Mascherini and Anna Rita Manca

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Contact information
Address: Via Enrico Fermi 2749 – Ispra(VA) - Italy
E-mail: massimiliano.mascherini@jrc.it
Tel.: +39 (0)332 785420
Fax: +39 (0)332 785733

http://ipsc.jrc.ec.europa.eu/
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1 Introduction

This paper presents a composite indicator to measure Effective Active Labour Market Policies (ALMP) using 16 indicators based on the Eurostat's Labour Market Policies DataBase. Alongside the composite index on Life Long Learning (LLL) previously elaborated, the present index has been developed within the joint DG EMPL/DG JRC project aimed to measure Flexicurity in the EU[1] through a set of four composite indicators corresponding to the four main pillars of flexicurity as identified in the 2006 Commission Communication on this topic (COM(2007) 359). The ALMPs index is computed following the methodology developed in the OECD/JRC handbook on composite indicators. The paper is organized as follows. Section 2 lists the indicators and presents their characteristics and problems. Section 3 presents the methodology adopted for computation of a composite indicator. Section 4 shows the results. Section 5 carries out uncertainty analysis of their robustness. Finally, section 6 presents results on a country-by-country basis.

2. The list of Indicators

The list of basic indicators for the ALMP composite indicator follows the theoretical framework developed together by DG EMPL/D1 and JRC/G09 and it is mainly based on the compendium of indicators developed by the Employment Committee to monitor Member States' progress towards the objectives set in the Employment Guidelines (hereinafter the Compendium). A set of 16 indicators were selected, all of them drawn from a unique data source: the Eurostat's Labour Market Policies database. This source covers all labour market policies or *interventions* undertaken by Member States, which are divided in three main categories:

1. Services: This category refers to labour market interventions where the main activity of participants is job search-related and where participation usually does not result in a change of labour market status.

2. Regular Activation Measures: This category refers to labour market interventions where the main activity of participants is other than job-search related and where participation usually results in a change in labour market status.

[1] This publication has been produced through a systematic collaboration between the Joint Research Centre (Institute for the Protection and Security of the Citizen) and the Directorate General of Employment, Social Affairs and Equal Opportunities (Unit D1, Employment Analysis, with Matteo Governatori acting as the main liaison person), within the joint research project "Statistical analysis in support of Flexicurity policy" (DG EMPL-JRC Administrative Arrangements 30566-2007-03).

3. Support: This category refers to interventions that provide financial assistance, directly or indirectly, to individuals for labour market reasons or which compensate individuals for disadvantages caused by labour market circumstances.

The LMP database is based on the collection of information from administrative sources, relating to public expenditure on and participants to the different types of labour market programs.

As the present exercise is exclusively focused on active policies, only indicators referring to the first two categories (i.e. services and activation measures) were retained. In fact, support measures essentially concern monetary transfers, i.e. measures of a more passive nature; hence they will be the focus of the Composite indicator on the social security component of flexicurity, to be built at a later stage within the project.

The quality of data and the geographical coverage of the indicators are overall satisfactory, although a significant number of missing values remains. The different aspects of data quality have been assessed through the application of commonly used statistical criteria. Each aspect has been classified following the standards adopted in the LIME project, with an evaluation ranging from a maximum (++) to a minimum (--).

Table 1 - List of indicators part of ALMP Composite Indicator

Indicators and Dimensions	Short name	Source
Expenditure as percentage of GDP		
LMP expenditure by type of action: cat 1, Labour market services	XTGDP1	EUROSTAT_LMP
LMP expenditure by type of action: cat. 2, Training	XTGDP2	EUROSTAT_LMP
LMP expenditure: cat.3, Job sharing and job rotation	XTGDP3	EUROSTAT_LMP
LMP expenditure: cat.4, Employment incentives	XTGDP4	EUROSTAT_LMP
LMP expenditure: cat.5, Supported employment and rehabilitation	XTGDP5	EUROSTAT_LMP
LMP expenditure: cat.6, Direct job creation	XTGDP6	EUROSTAT_LMP
LMP expenditure: cat.7, Start-up incentives	XTGDP7	EUROSTAT_LMP
Spending per participant in millions euros		
Spending per participant Training	spending2	EUROSTAT_LMP
Spending per participant Job sharing and job rotation	spending3	EUROSTAT_LMP
Spending per participant Employment incentives	spending4	EUROSTAT_LMP
Spending per participant Supported employment and rehabilitation	spending5	EUROSTAT_LMP
Spending per participant Direct job creation	spending6	EUROSTAT_LMP
Spending per participant Start-up incentives	spending7	EUROSTAT_LMP
Spending/participants per person wanting to work		
LMP services (cat 1): spending per person wanting to work	LMPservices	EUROSTAT_LMP
LMP measures (cat 2-7): spending per person wanting to work	LMPmeasures	EUROSTAT_LMP
Total regular activation: % of participants in LMP measures (cat. 2-7) over total number of persons wanting to work	tot ra	EUROSTAT_LMP

Table 1 reports the complete list of indicators used for the calculation of the ALMPs Composite Indicator divided by three dimensions.

The first dimension captures the overall amount of expenditure on the different Active Labour Market Policies. Hence, it includes the expenditure on services and activation measures expressed as share of GDP and broken down by type of program (7 indicators in total, see table 1 for details).

The second dimension captures the intensity of ALMPs provision per participant. Hence it includes the expenditure on activation measures (in Millions of Euros) per participant. The indicator is broken down by type of program, so that overall 6 indicators are included, one less than in the previous dimension as for category 1 (services), being it a general measure, no number of participants is reported in the LMP database.

After overall spending and spending per participant, the third dimension measures the intensity of Member States' activation efforts relative to the overall number of people who should be, in principle, targeted by such efforts. Hence, it includes two kinds of indicators:

- The amount of spending on services and activation measures (the first two indicators, respectively) per person wanting to work
- The number of participants to activation measures (third indicator), expressed as percentage of the total number of persons wanting to work.

The **time coverage** of the ALMPs Composite indicator goes from 2004 to 2007. Using the LIME statistical standards, such time coverage can be rated with a "++". The nature of the LMP database would make it possible to update the ALMP composite indicator annually.

The **geographical coverage** is rated as "++" following the LIME standards and counts 24 member states for the years 2005, 2006 2007 and 22 member states for 2004.

The **number of missing data** is presented in table 2. This is quite significant with only a few countries having a complete dataset. This aspect of quality of data can be then rated with a "--". As a pre-condition to compute the composite indicator, the problem of missing data is to some extent tackled through imputation techniques.
This calls for particular caution; hence the effect of imputed values on final results of the composite indicator was assessed through uncertainty analysis. Moreover, as a way to limit the use of imputation techniques to the minimum, member states presenting a number of missing data greater than six in any year over the chosen time horizon were excluded from the data-set for that(those) year(s). This resulted in the total removal of Denmark, Malta, Greece and Cyprus from the analysis and in the partial removal of Poland and Slovenia, which were not considered for 2004 only. Table 2 reports the number of missing data over the total number of indicators considered by country and year.

Table 2 - Missing data over the total number of basic indicators

Country	2004	2005	2006	2007
AT	1/16	1/16	1/16	0/16
BE	2/16	2/16	2/16	0/16
BG	8/16	2/16	2/16	0/16
CY	16/16	16/16	8/16	4/16
CZ	3/16	2/16	2/16	0/16
DE	0/16	0/16	0/16	9/16
DK	4/16	16/16	16/16	16/16
EE	7/16	6/16	4/16	0/16
ES	2/16	3/16	2/16	10/16
FI	0/16	0/16	0/16	0/16
FR	2/16	2/16	2/16	6/16
GR	10/16	10/16	14/16	16/16
HU	4/16	4/16	4/16	0/16
IE	4/16	5/16	4/16	0/16
IT	3/16	3/16	4/16	2/16
LT	4/16	5/16	2/16	5/16
LU	6/16	5/16	4/16	0/16
LV	6/16	4/16	4/16	0/16
MT	16/16	16/16	8/16	4/16
NL	2/16	6/16	6/16	6/16
NO	3/16	4/16	5/16	2/16
PL	13/16	4/16	3/16	3/16
PT	3/16	2/16	1/16	1/16
RO	5/16	5/16	5/16	1/16
SE	3/16	2/16	2/16	0/16
SI	16/16	4/16	4/16	0/16
SK	3/16	2/16	2/16	1/16
UK	3/16	4/16	4/16	2/16

The **direction of indicators** has been assumed to be positive for all of them, i.e. the higher the score recorded, the better the performance.

Correlations among indicators are probably the major issue within the process of constructing a composite indicator. Although the identification and removal of redundant indicators is still a controversial topic among researchers, correlation analysis remains a useful tool to that purpose. However, as highlighted in the literature, the mechanical application of correlation analysis is not sufficient to identify redundant indicators. Within a pair of indicators, one of them can be considered redundant when it is both highly correlated *and* with a similar meaning to the other.

Table 3 presents the correlation matrix for 2004. A high positive correlation is recorded, for instance, between *spending_4* and *spending_2* (see table 1 above for short names of all indicators), i.e. when spending per participant in employment incentives is larger, spending per participant in training also tends to be larger. However, both indicators have been kept in the analysis as they concern two different types of policies, hence their meaning is different. Indicators *LMP services* and *XTGDP1* are also highly correlated,

implying that the higher is the expenditure in Labour Market services per person wanting to work the higher is the expenditure as share of GDP in labour market services. Both variables have been kept in the analysis due to their different meaning.

The same reasoning is applied in the correlation analysis for subsequent years. Table 4, 5 and 6 present the correlation matrices for 2005, 2006 and 2007, respectively. High correlation between spending on services as a share of GDP and per person wanting to work is recorded throughout the whole period considered, whereas spending per participant in training and in employment incentives are highly correlated also in 2005, but not in the following years. Finally, in 2007 two further pairs of variables record high correlation, i.e. XTGDP5 (expenditure in supported employment as a share of GDP) and XTGDP1 (expenditure in labour market services as a share of GDP), on the one hand, and *spending5* (i.e. spending per participant in supported employment and rehabilitation) and *LMP measure (*expenditure in activation measures per person wanting to work*).*

As all the above mentioned cases of correlation concern pairs of indicators having a different meaning, none of them was removed from the analysis for any year.

Table 3 - Correlation matrix of basic indicators for 2004

	xtgdp1	xtgdp2	xtgdp3	xtgdp4	xtgdp5	xtgdp6	xtgdp7	spen~2	i_spen~3	spen~4	spen~5	spendi~6	spendi~7	lmpmea~s	lmps~s	tot_ra
xtgdp1	1															
xtgdp2	0.27	1														
i_xtgdp3	-0.02	0.41	1													
xtgdp4	-0.04	0.44	0.24	1												
xtgdp5	0.68	0.31	0.10	0.14	1											
xtgdp6	0.29	0.14	-0.07	0.02	0.19	1										
xtgdp7	0.09	0.27	0.01	0.21	0.12	-0.09	1									
spending2	0.06	0.45	0.21	0.37	0.14	-0.18	0.03	1								
spending3	0.05	0.34	0.04	0.03	0.00	-0.16	-0.05	0.24	1							
spending4	0.24	0.52	0.22	0.20	0.13	-0.01	0.12	**0.81**	0.07	1						
spending5	0.08	0.37	0.07	0.07	0.13	-0.02	-0.06	0.56	0.55	0.39	1					
spending6	0.53	0.51	0.06	-0.14	0.35	0.29	-0.14	0.43	0.39	0.47	0.71	1				
spending7	-0.25	0.26	0.01	0.34	0.03	-0.27	0.36	0.46	0.14	0.21	0.01	-0.08	1			
lmpmeasures	0.32	0.42	0.05	0.39	0.44	0.25	-0.05	0.51	0.01	0.45	0.71	0.62	-0.07	1		
i_lmpservi~s	**0.81**	0.29	-0.03	0.18	0.48	0.30	-0.05	0.30	0.04	0.40	0.40	0.62	-0.28	0.69	1	
tot_ra	0.30	0.43	0.02	0.48	0.36	0.51	0.01	0.23	-0.07	0.17	0.42	0.50	-0.10	0.78	0.55	1

Table 4- Correlation matrix of basic indicators for 2005

	xtgdp1	xtgdp2	_xtgdp3	xtgdp4	xtgdp5	xtgdp6	xtgdp7	i_spen~2	i_spen~3	i_spen~4	i_spen~5	spendi~6	spendi~7	lmpmea~s	i_lmps~s	tot_ra
xtgdp1	1															
xtgdp2	0.21	1														
i_xtgdp3	0.00	0.48	1													
xtgdp4	0.08	0.40	0.55	1												
xtgdp5	0.66	0.30	0.21	0.32	1											
xtgdp6	0.16	0.10	-0.17	0.01	0.04	1										
xtgdp7	0.06	0.11	0.16	0.18	0.00	-0.17	1									
i_spending2	0.10	0.71	0.39	0.42	0.13	-0.06	-0.08	1								
i_spending3	0.11	0.64	0.45	0.27	0.09	-0.23	0.16	0.32	1							
i_spending4	0.52	0.59	0.32	0.31	0.59	0.11	-0.01	**0.73**	0.13	1						
i_spending5	0.20	0.34	0.06	0.05	0.16	-0.11	-0.15	0.57	0.39	0.40	1					
spending6	0.28	0.49	-0.08	-0.10	0.16	0.21	-0.30	0.66	0.13	0.58	0.76	1				
spending7	-0.33	0.15	0.09	0.23	-0.02	-0.27	0.34	0.21	0.03	-0.01	-0.14	-0.13	1			
lmpmeasure	0.16	0.35	0.10	0.38	0.31	0.17	-0.21	0.68	0.04	0.66	0.67	0.65	-0.08	1		
i_lmpservi~s	**0.82**	0.08	-0.05	0.15	0.61	0.14	-0.17	0.25	0.02	0.62	0.46	0.44	-0.30	0.55	1	
tot_ra	0.15	0.33	0.05	0.59	0.20	0.31	0.08	0.43	-0.02	0.37	0.34	0.41	-0.12	0.72	0.35	1

Table 5 - Correlation matrix of basic indicators for 2006

	xtgdp1	xtgdp2	_xtgdp3	xtgdp4	xtgdp5	xtgdp6	xtgdp7	i_spen~2	i_spen~3	_spen~4	i_spen~5	spendi~6	spendi~7	lmpmea~s	i_lmps~s	tot_ra
xtgdp1	1															
xtgdp2	0.22	1														
i_xtgdp3	0.03	0.47	1													
xtgdp4	0.04	0.38	0.63	1												
xtgdp5	0.61	0.21	0.25	0.29	1											
xtgdp6	0.18	0.12	-0.13	0.00	0.07	1										
xtgdp7	0.05	0.28	0.14	0.24	-0.11	-0.10	1									
i_spending2	0.09	0.63	0.45	0.45	0.13	-0.07	-0.10	1								
i_spending3	0.09	0.61	0.22	0.10	0.01	-0.13	0.14	0.26	1							
i_spending4	0.59	0.50	0.40	0.29	0.56	0.11	0.03	0.66	0.04	1						
i_spending5	0.20	0.33	0.07	0.11	0.14	-0.11	-0.19	0.60	0.47	0.37	1					
spending6	0.30	0.43	-0.11	-0.11	0.16	0.27	-0.23	0.63	0.24	0.53	0.75	1				
spending7	-0.33	0.14	0.07	0.21	-0.02	-0.23	0.23	0.20	0.02	-0.05	-0.18	-0.14	1			
lmpmeasure	0.21	0.38	0.18	0.42	0.37	0.22	-0.14	0.70	0.06	0.66	0.70	0.68	-0.08	1		
i_lmpservi~s	**0.83**	0.10	-0.02	0.13	0.64	0.14	-0.14	0.22	0.04	0.66	0.47	0.42	-0.28	0.55	1	
tot_ra	0.17	0.31	0.07	0.59	0.19	0.33	0.32	0.34	-0.01	0.26	0.32	0.36	-0.09	0.64	0.32	1

Table 6 - Correlation Matrix of basic indicators for 2007

	xtgdp1	xtgdp2	_xtgdp3	xtgdp4	xtgdp5	xtgdp6	xtgdp7	i_spen~2	i_spen~3	i_spen~4	i_spen~5	spendi~6	spendi~7	lmpmea~s	i_lmps~s	tot_ra
xtgdp1	1															
xtgdp2	0.20	1														
i_xtgdp3	-0.05	0.45	1													
xtgdp4	0.06	0.24	0.22	1												
xtgdp5	**0.82**	0.18	0.13	0.27	1											
xtgdp6	0.04	0.29	-0.03	0.28	-0.08	1										
xtgdp7	0.00	0.33	0.06	0.06	-0.08	0.04	1									
i_spending2	0.00	0.37	0.32	0.32	0.08	-0.04	-0.04	1								
i_spending3	0.04	0.59	0.66	0.38	0.10	-0.11	0.38	0.28	1							
i_spending4	0.36	0.53	0.32	0.38	0.45	0.16	0.07	0.62	0.49	1						
i_spending5	0.11	0.36	0.09	0.17	0.17	-0.09	-0.15	0.50	0.15	0.33	1					
spending6	0.00	0.48	0.04	-0.06	-0.10	0.31	-0.08	0.62	-0.02	0.39	0.69	1				
spending7	-0.24	0.15	0.04	0.21	0.06	-0.09	0.22	0.30	0.08	0.08	-0.09	-0.01	1			
lmpmeasure	0.24	0.31	0.06	0.46	0.30	0.26	-0.13	0.54	0.07	0.60	**0.76**	0.58	-0.04	1		
i_lmpservi~s	**0.95**	0.15	-0.08	0.10	0.80	0.04	-0.13	0.09	-0.06	0.42	0.26	0.10	-0.24	0.45	1	
tot_ra	0.15	0.37	-0.02	0.56	0.16	0.39	0.06	0.31	0.00	0.29	0.67	0.48	-0.06	0.84	0.32	1

3. Methodological Assumptions

Nardo et al. (2005) define a composite indicator as "a mathematical combination of individual indicators that represent different dimensions of a concept whose description is the objective of the analysis" (p.7). Following this logic, we summarize the concept of Active Labour Market Policies into one number; encompassing all relevant dimensions for which data are currently available. To create this composite indicator the methodological guidelines of Nardo et al. (2005) were thoroughly followed.

A composite indicator is ultimately the sum of all its parts; hence the methodological assumptions made for its calculation need to be clear and well justified. In general, different methodological decisions can be taken, provided that they are supported by the relevant theoretical framework and their effects on the indicators' final values are carefully evaluated. In the present exercise, methodological choices need to be made with respect to the following elements:

a) the structure of the composite indicator
b) the imputation of missing data.
c) the aggregation rule
d) the standardization formula
e) the weighting system

Based on the theoretical framework developed in cooperation with Unit D1 in DG Employment, the composite indicator has been constructed following the methodological assumptions specified below and already adopted for the construction of the LLL composite indicator (Mascherini; 2008, see above).

3.1 The structure of composite indicator

The composite indicator for ALMPs has a relatively simple structure although, unlike the indicator for LLL, it includes different levels of aggregation of input indicators. It consists of three different pillars or dimensions, corresponding to those highlighted in section 2 and in table 1 above:

1. Overall expenditure on ALMPs (i.e. *spending as a share of GDP); including* 7 indicators corresponding to the different types of policies.
2. *ALMPs spending per participant*; including 6 indicators (as there is no participants' number for labour market services).
3. *Intensity of ALMPs per person wanting to work;* including 3 indicators.

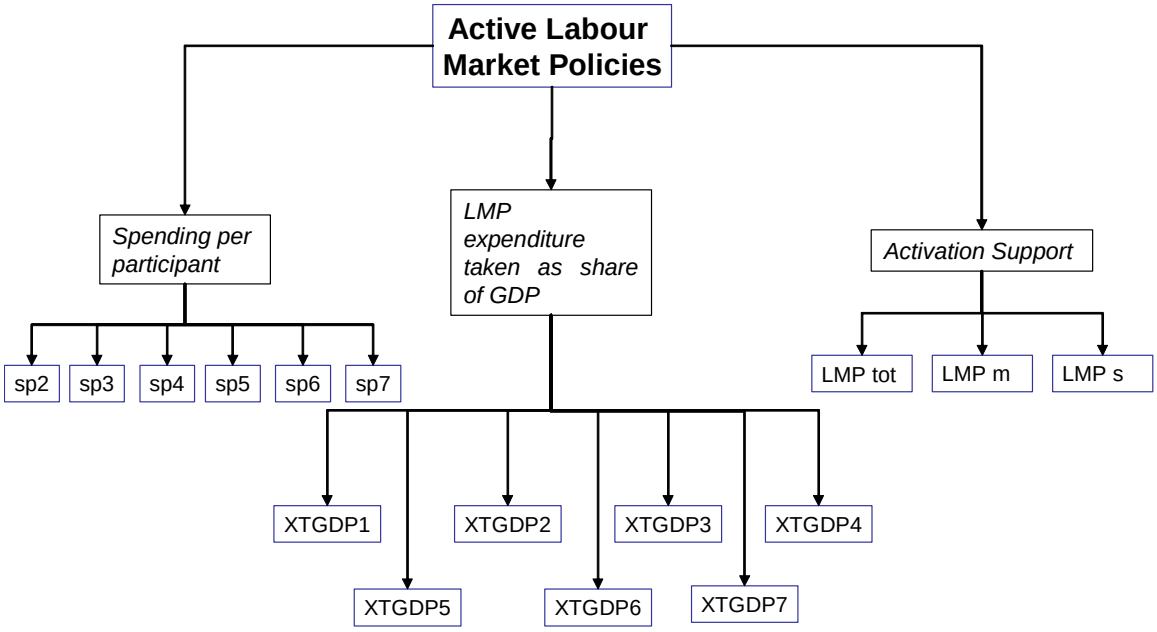


Figure 1: The structure of the ALMPs Composite Indicator

The effect of alternative structures of the composite indicator on the final ranking of countries is discussed in the section on uncertainty analysis below.

3.2 The imputation of data

Missing data were the most problematic issue in this exercise, as the construction of a composite indicator requires, ideally, a complete dataset. There are three main methods to deal with this issue: 1) case deletion, 2) single imputation and 3) multiple imputations. The first one omits the missing records from the analysis. It has the advantage of maintaining the original data-set and the disadvantage of reducing the overall number of observations in the analysis. The two remaining approaches consider missing data as part of the analysis and aim at imputing values through different techniques: single imputation, such as hot deck or mean/median/mode/ substitution, regression imputation etc., (Little. and Schenker, 1994; Little, 1997, Little and Rubin 2002), or multiple imputations, like Markov Chain Monte Carlo (MCMC) algorithm, (Gilks, Richardson and Spiegelhalter, 1996; Schafer, 1999; Rubin and Schenker,1986), , In order to use a simple approach and to avoid "black box" techniques such as, for instance, multiple imputations, while at the same time keeping the largest possible number of Member States within the analysis, a three steps strategy has been applied:

1. For each member state, whenever possible, the value of the previous/following year (or the average of values over all available years) was imputed to the missing indicator. This is a hot-deck type of approach, based on proximity criteria.
2. For each member state, whenever an indicator was missing throughout the entire period considered, missing values were imputed through the regression imputation method.

3. The effect of imputed values on the final ranking of countries was tested through an extensive MCMChain simulation.

In order to test the effect of the imputation on the ranking of the composite indicator, the imputation uncertainty factor will be included into the uncertainty analysis.

3.3 The standardization scheme

Being the 16 basic indicators expressed with different scales, they need to be standardized as a pre-condition for their aggregation. Different standardization techniques are available (Nardo et al., 2005). In this exercise the Min-Max approach adapted for the 4 years time-coverage has been applied. Each original indicator q has then been standardized based on the following rule (where t indicates the year and c the country)

$$I^{t}{}_{qc} = \frac{x^{t}{}_{qc} - \min_{c}(x_{q}^{2004-2007})}{\max_{c}(x_{q}^{2004-2007}) - \min_{c}(x_{q}^{2004-2007})} \cdot 1000 .$$

Using this method, all indicators have been rescaled in such a way as to lie between 0 (laggard $x_{qc}=\min_c(x^{2004\text{-}2007}{}_q)$) and 1000 (leader, $x_{qc}=\max_c(x^{2004\text{-}2007}{}_q)$). Where $\max_c(x^{2004\text{-}2007}{}_q)$ and $\min_c(x^{2004\text{-}2007}{}_q)$ are respectively the maximum and the minimum value of the indicator over all countries and years considered. In order to assess the robustness of the composite indicator, alternative standardization methods have been applied in the context of the uncertainty and sensitivity analysis (see below).

3.4 The weighting scheme

Following on the standardization process, it is important to ensure that for every indicator a higher score corresponds to a better performance of the country, so that the different indicators can be meaningfully aggregated. In the present case this condition was fulfilled and so no transformation was needed.

The weighting scheme adopted for the construction of the Composite Indicator consists of attributing equal weights to all indicators within the same dimension. This strategy avoids rewarding those dimensions which include more indicators (e.g. Expenditure as percentage of GDP) relative to those with fewer ones (e.g. Spending/participants per person wanting to work). As a result, although variables are not given the same weight overall, all dimensions included in the indicator are equally important. Table 7 below presents the numerical values of the weights.

Table 7 - Weighting scheme for the ALMP composite indicator

Dimension	Weight	Basic Indicator	Weight	Normalized Value
LMP expenditure taken as share of GDP	1/3	*XTGDP1*	1/7	0.0476
		XTGDP2	1/7	0.0476
		XTGDP3	1/7	0.0476
		XTGDP4	1/7	0.0476
		XTGDP5	1/7	0.0476
		XTGDP6	1/7	0.0476
		XTGDP7	1/7	0.0476
Spending per participant	1/3	*spending cat.2*	1/6	0.0556
		spending cat.3	1/6	0.0556
		spending cat.4	1/6	0.0556
		spending cat.5	1/6	0.0556
		spending cat.6	1/6	0.0556
		spending cat.7	1/6	0.0556
Activation Support	1/3	*LMP tot*	1/3	0.1111
		LMP measures	1/3	0.1111
		LMP services	1/3	0.1111

3.3 The aggregation rule

The issue of aggregation of the information conveyed by the different dimensions into a composite index comes together with the weighting. Different aggregation rules are possible. Sub-indicators could be summed up (e.g. linear aggregation), multiplied (geometric aggregation) or aggregated using non linear techniques (e.g. multi-criteria analysis). Each technique implies different assumptions and has specific consequences.

In this paper, for each year considered, a simple linear aggregation rule was adopted, implying that basic indicators are aggregated according to the structure of the indicator (see above 3.1) and the following formula:

$$Y_c^t = \sum_{i=1}^{3} w_i \sum_{j=1}^{k_i} w_j^* I_{ijc}^t$$

Where t is the year of reference, w are the weights of the 3 dimensions, w^* are the weights of basic indicators within each dimension, I the basic indicators and c the country index. Different aggregation rules have been tested within the sensitivity analysis.

4. Results

After having defined the structure, the weighting scheme and the standardization procedure, the computation of the ALMP composite indicator can be performed. This section presents and discusses the results of the indicator in terms of Member States' ranking over the four-years period considered.

Table 8 presents the score of the composite indicator by country for 2004, as well as the corresponding ranking. Luxembourg, Norway and Sweden rank at the top, followed by the Netherlands, Germany and Belgium. Within the group of Mediterranean countries, Italy performs relatively better, being ranked in the 11th position, followed by Spain in 12th position. Romania, ranked in the 14th position, is the first among Central and Eastern European Members States which, as a group, tend to rank at the lower end of the scale. Like for every composite indicator, the overall score may mask divergent situations across individual dimensions or basic variables. Estonia, for instance, is in the 21st position, i.e. the last but one, with respect to the composite indicator, although it records a much better score (the second one among new Member States and the 15th one overall) with respect to spending per participant in training.

Table 8 - 2004 ALMP composite indicator

Rank	Country	Score 2004
1	LU	385.66
2	SE	344.37
3	NO	344.08
4	NL	315.47
5	DE	313.02
6	BE	299.92
7	FI	288.09
8	AT	287.08
9	IE	256.70
10	FR	247.57
11	IT	190.20
12	ES	173.29
13	UK	148.15
14	RO	141.75
15	PT	136.16
16	BG	74.66
17	HU	59.31
18	CZ	50.24
19	SK	37.92
20	LT	35.61
21	EE	31.74
22	LV	29.45

Table 9 presents results by country for 2005. There are no major deviations from the ranking in 2004, as countries in the top four positions are still the same, with Sweden and Norway switching their position with each other. Finland is ranked 5th , followed by Ireland and Belgium. Italy is still ranked first among Mediterranean countries, i.e. in 11th position, followed by Spain, 12th, and Portugal, 13th, the latter country performing better than in 2004. Poland ranks first among new Member States, followed by Bulgaria in 18th position and Hungary in 19th position. Romania registers a sharp deterioration of its ranking with respect to 2004, moving from the 14th to the 21st position. Finally, Latvia and Estonia are located at the bottom of the ranking, as in 2004.

Table 9 - 2005 ALMP composite indicator

Rank	Country	Score 2005
1	LU	414.57
2	SE	347.92
3	NO	339.82
4	NL	328.16
5	FI	279.75
6	BE	277.85
7	IE	258.54
8	DE	251.51
9	AT	236.42
10	FR	211.05
11	IT	196.44
12	ES	178.27
13	PT	162.83
14	UK	159.48
15	PL	113.49
16	SI	104.08
17	SK	75.92
18	BG	72.52
19	HU	62.98
20	CZ	50.31
21	RO	42.89
22	LT	41.08
23	LV	38.66
24	EE	37.88

Table 10 presents results for 2006. Luxembourg maintains its first position, whereas the Netherlands improves its ranking by moving to the 3rd position, followed by Norway, Spain (11th) becomes the top performer among Mediterranean Member States, followed by Italy, 12th, and Portugal, 14th. Poland and Slovenia rank better compared to the other new Member States which, again, tend to rank at the bottom as a group. Again, overall scores need to be taken with caution as, for instance, Latvia performs rather well with respect to the expenditure in employment incentives, where the country is ranked in the 3rd position, despite being located at the lower end of the scale with respect to the composite indicator. Estonia is ranked in the last position.

Table 10 - 2006 ALMP composite indicator

Rank	Country	Score 2006
1	LU	390.80
2	SE	376.38
3	NL	328.11
4	NO	299.60
5	FI	288.93
6	BE	287.70
7	AT	271.02
8	IE	263.60
9	DE	257.87
10	FR	224.11
11	ES	217.92
12	IT	200.32
13	UK	149.38
14	PT	142.30
15	PL	114.90
16	SI	92.77
17	SK	72.80
18	BG	68.39
19	HU	59.89
20	LT	54.06
21	CZ	53.66
22	LV	48.84
23	RO	45.51
24	EE	31.58

Table 11 presents results for 2007. It highlights only slight differences compared to previous years. Luxembourg still ranks at the top, followed by the Netherlands and Belgium. Nordic countries such as Norway, Sweden and Finland also rank in the upper end of the scale. Spain, in 11th position, performs better among Mediterranean Countries, followed by Italy, whereas Poland maintains its top ranking among new Member States, followed by Hungary and Slovenia. Romania and Estonia are located in the last two positions.

Table 11 - 2007 ALMP composite indicator

Rank	Country	Score 2007
1	LU	468.18
2	NL	365.95
3	BE	356.97
4	NO	321.95
5	SE	320.30
6	FI	294.55
7	IE	282.15
8	DE	261.68
9	AT	255.17
10	FR	245.77
11	ES	191.22
12	IT	189.47
13	UK	140.02
14	PL	134.12
15	PT	127.32
16	HU	74.60
17	SI	63.38
18	SK	62.99
19	LT	61.84
20	CZ	58.87
21	BG	58.14
22	LV	39.22
23	RO	35.28
24	EE	29.28

Figure 2 and table 12 compare member states' rankings across the four years considered. Overall, the ranking is quite stable over time with only slight changes between 2004 and 2007. Nordic countries, together with Luxembourg and Belgium constantly rank in top positions, whereas Southern Member States tend to rank in intermediate positions, together with the UK and, finally, New Member States systematically cluster on the lower end of the ranking. However, some changes over time can still be observed. Romania, for instance, presents a better performance in 2004 than in the remaining years, whereas Slovakia improves its performance from the 21st position in 2004 to the 18th in 2007 and Lithuania moves from the 22nd to the 18th position throughout the period. Finally, many countries register just slight changes, such as Austria which gravitates around position 8, Italy (around position 11th) and the Czech Republic (around position 20th).

Table 12 - Comparison of the rankings 2004-2007

	2004	2005	2006	2007
AT	8	9	7	9
BE	6	6	6	3
BG	16	18	18	21
CZ	18	20	21	20
DE	5	8	9	8
EE	21	24	24	24
ES	12	12	11	11
FI	7	5	5	6
FR	10	10	10	10
HU	17	19	19	16
IE	9	7	8	7
IT	11	11	12	12
LT	20	22	20	19
LU	1	1	1	1
LV	22	23	22	22
NL	4	4	3	2
NO	3	3	4	4
PL		15	15	14
PT	15	13	14	15
RO	14	21	23	23
SE	2	2	2	5
SI		16	16	17
SK	19	17	17	18
UK	13	14	13	13

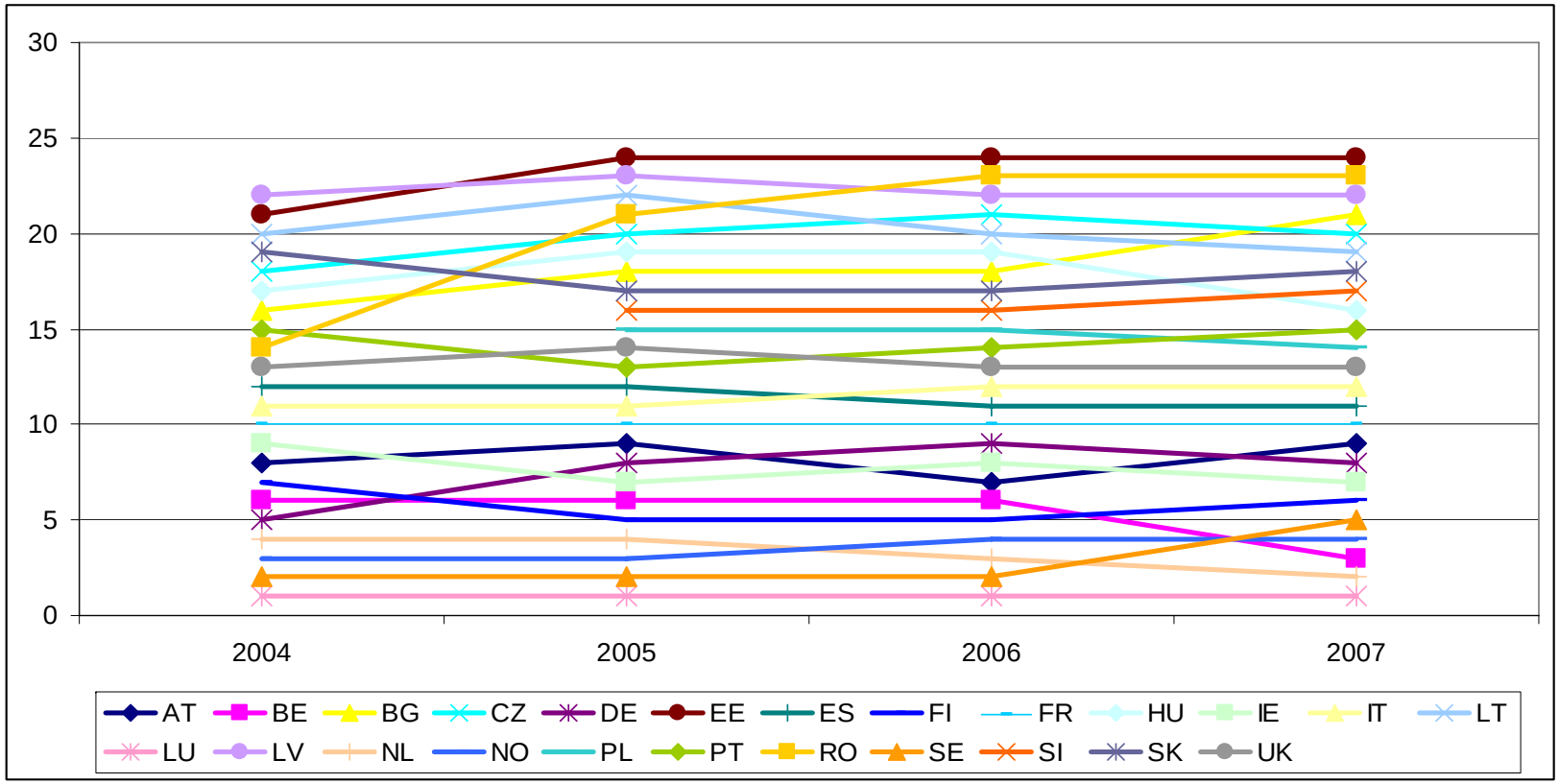


Figure 2 - Ranking Comparison 2004-2007

5. Uncertainty and Sensitivity Analysis.

In order to assess the robustness of the ALMP composite indicator the main sources of uncertainties underlying the index as well as the sensitivity of country scores/rankings to the methodological approach adopted need to be evaluated. This section presents the main conclusions of the uncertainty analysis. Further details are available in the Annex.

Every composite index, including the present one, involves subjective judgments in several steps of its calculation procedure, such as the selection of indicators, the choice of aggregation model, the imputation of missing data and the weights applied to the indicators. This implies that the quality and reliability of an index as well as the uncertainties associated with the methodology followed for its construction need to be evaluated. Moreover, to ensure the validity of the policy conclusions drawn from the ALMP indicator, it is important to analyze the sensitivity of the index to alternative methodological assumptions. A combination of uncertainty and sensitivity analyses can help to gauge the robustness of the indicator's results, to increase its transparency and to help frame the debate about its use.

Five main sources of uncertainty can be highlighted and their combined effect on country rankings needs to be tested:

1) Data Normalization
2) Weighting Scheme
3) Composite Indicator Formula (Aggregation Rule)
4) Inclusion/Exclusion of Basic Indicators
5) Imputation of Missing Data via MCMC.

Essentially, uncertainty analysis is carried out through computer simulations. First, the five above mentioned sources of uncertainty are turned into 5 input factors with uniform probabilities across the different alternatives they can take, i.e. the different approaches and methods (see table 13). Then, all possible combinations of input factors are simulated. This would result, in principle, in 36000 combinations with corresponding sets of indicators' values and country rankings. However only 23800 of them produce a valid scenario and are, therefore, retained in the analysis.

Table 13 - uncertainty factors for the ALMP composite indicator

X_1	Standardization
1	Z-Score
2	Min-Max
3	Ranking across countries

X_2	Weighting Scheme
1	Equal Weight
2	Predetermined set of Weights
3	PCA weights
4	DEA weights

X_3	Aggregation Rule
1	Linear
2	Geometric
3	No further Aggregation (for DEA)

X_4	Excluded Sub-Indicator
1	Indicator 1 omitted
2	Indicator 2 omitted
3	Indicator 3 omitted
...	...
15	Indicator 15 omitted
16	Indicator 16 omitted

X_5	Imputation of Missing Data via MCMC
1	Sample 1 of the set of missing data randomly simulated.
2	Sample 2 of the set of missing data randomly simulated.
3	Sample 3 of the set of missing data randomly simulated.
…	...
100	Sample 100 of the set of missing data randomly simulated..

Following on this, for every country the distribution of possible rankings across the 23800 simulations is assessed. The variability of these distributions can be considered as the result of the uncertainty underlying the construction process of the composite indicator. It is more appropriate to discuss ranks and not scores because the non-normal character of the data, The results of the simulations can then be organized in a frequency matrix and the overall ALMP indicator is calculated across the 23800 scenarios. Besides the frequency matrix, the median rank per country was selected as benchmark to be compared with the rank recorded in the ALMP composite indicator as presented in section 3 above. Frequency distribution matrices are presented below, for each of the four years considered.

On table 15 an example of frequency distribution of a country rank over the 23800 scenarios is presented. A colour code is used to distinguish different frequencies as illustrated in table 14:

Table 14 - Colour Codes

	Frequency lower than 10%
	Frequency between 10% and 20%
	Frequency between 20% and 35%
	Frequency between 35% and 50%
	Frequency higher than 50%
bold	Position in the ALMP composite indicator
Italic	median
Red	mode of the distribution

Moreover, **Bold**, *Italic* and Red represent the country rank in the ALMP composite indicator, the median and the mode of the 23800 simulations, respectively. For example Austria in 2004 has a distribution encoded as follows, Table 15:

Table 15 – Frequencies of Austria performance in the 23800 scenarios in 2004.

Rank	4	5	6	7	8	9	10
AUSTRIA	1.36%	3.97%	14.74%	25.14%	***17.96%***	8.59%	28.24%

This means that the country is ranked in positions 4th to 10th among the 23800 simulations performed. In particular, Austria is ranked in position 4th, 5th and 9th with a frequency lower than 10%, in position 6th and 8th with a frequency between 15% and 30% and in position 7th and 10th with a frequency between 25% and 35%. Position 10th is the mode, whereas the median falls in position 8th which is also the position of the country in the composite indicator.

In the following tables, the frequency matrices for the period 2004-2007 are presented. Due to the huge number of simulation performed, just frequencies higher than 5% are shown. Most countries show a moderate degree of variability in their ranking, mainly as a result of imputation of missing data. The extent of such variability varies to some extent across countries. In this section a general overview of the results of uncertainty analysis is given, whereas the specific situation of each country is commented in the country profile section.

The frequency matrix for 2004 is shown in Figure 3. Although the results of uncertainty analysis for this year show some variability in the ranking of countries, the overall situation does not contradict the ranking of the composite indicator presented in table 8. In particular, Luxembourg is the leader of the ranking in the 40% of the 23800 different scenarios performed and in almost 80% of the cases is ranked in the top 4 positions. The same holds for Sweden which is ranked in the top 3 positions in 80% of the cases. Less robust is the ranking of Norway, although the country is ranked within the first six positions in the 92% of cases. Germany and Austria show a bi-modal distribution of frequencies, but in both cases the median of the distribution corresponds to the position

recorded in the composite indicator. The rank of Italy and Spain appears very robust, as it is concentrated within positions 11th -13th in more than 94% of the scenarios considered. The same occurs for Romania which is ranked between position 16th and 17th in 96% of the simulations performed. Similar results are found for the remaining countries.

Results for 2005 highlight some increase in the variability in countries' ranking although the overall situation still does not contradict the composite indicator presented above. Despite the increase in variability, all countries record a rank which varies across a maximum of +/- 2 positions compared with that identified in the composite indicator. This trend is confirmed in more than 70% of the 23800 different scenarios considered. Moreover, results are even more robust in some countries, such as Portugal, Poland, or Slovakia. In those cases the rank varies within 3 positions in more than 85% of the different scenarios. The situation is even better for France and Estonia which show a very robust situation with a ranking varying across just two positions in more than 85% of the cases. On the other hand, some bi-modal patterns appear for Sweden and Norway, implying that some assumptions in the possible sources of uncertainty can affect the country ranking in some cases.

The results of the uncertainty analysis for 2006, despite presenting a slight increase in the variability of country ranking, confirm the country positions of the composite indicator shown in table 10. The frequency matrix for 2006 is presented in Figure 5. As for previous years Luxemburg, Sweden and the Netherlands, respectively the first, the second and the third of the "league", rank in the first three positions in almost 80% of the cases. Less robust is the rank of Belgium which spreads from the 4th to the 9th position in 73% of possible scenarios. Germany presents a similar situation to Belgium: these results are likely to be due to the imputation of missing data. On the other hand the situation is better for countries such as France, Italy and Poland, the ranking of which changes within 3 positions in more than 90% of different scenarios. The situation is even better for Slovenia, Romania and Estonia which show a very robust situation with a ranking varying between only two positions in more than 90% of the cases.

Finally the uncertainty analysis results for 2007 also confirm the country position identified in the composite indicator. Among the four years considered, on the whole, 2007 is characterized by more missing data and for this reason the rank is less robust than for previous years. Despite this fact, most countries record a ranking which varies for a maximum of +/- 2 positions compared with that identified in the composite indicator. This trend is observed in more than 50% of the 23800 different scenarios considered. In particular Luxemburg, the leader of the "league", varies between the first two positions in 50% of cases and ranks in the first position in 43% of the 23800 different scenarios performed. The situation is better for some countries such as Italy, Spain, Poland, Hungary and Lithuania, because in those cases the rank varies within 2 positions in more than 70% of the different scenarios. The situation is even better for Romania and Estonia which present a very robust situation where the ranking of the country varies between two positions in more than 90% of the cases. On the other hand, the case of the Netherlands presents a less robust situation with a bi-modal pattern due to some assumptions in the sources of uncertainty.

Figure 3 - Uncertainty Analysis frequency matrix for 2004

2004		LU	SE	NO	NL	DE	BE	FI	AT	IE	FR	IT	ES	UK	RO	PT	BG	HU	CZ	SK	LT	EE	LV
Rank	1	40.01%	27.63%	15.35%		10.35%																	
Rank	2	16.83%	28.17%	11.24%	17.63%	19.69%	5.87%																
Rank	3	10.94%	23.55%	15.03%	18.14%	13.94%	14.08%																
Rank	4	10.12%	6.95%	16.66%	14.17%	12.85%	28.92%																
Rank	5	6.82%		12.71%	12.24%	29.81%	17.85%	7.26%															
Rank	6			21.03%	12.05%	10.05%	18.34%	8.85%	14.74%														
Rank	7						7.64%	16.98%	25.14%	20.67%	12.26%												
Rank	8							23.29%	17.96%	23.67%	19.77%												
Rank	9							24.67%	8.59%	32.75%	20.86%												
Rank	10							11.63%	28.24%	17.35%	31.05%												
Rank	11											23.09%	49.26%	26.67%									
Rank	12											48.43%	25.95%	17.17%									
Rank	13											23.45%	21.55%	34.63%	7.78%	12.58%							
Rank	14													16.95%	26.95%	48.69%							
Rank	15														53.68%	30.22%			6.18%				
Rank	16																23.09%	56.03%	15.99%				
Rank	17																17.30%	37.59%	38.84%				
Rank	18																56.86%		38.76%				
Rank	19																			53.60%	35.43%	8.43%	
Rank	20																			21.66%	35.53%	24.91%	17.24%
Rank	21																			14.83%	27.31%	23.82%	34.04%
Rank	22																			7.86%		42.30%	48.38%

Figure 4 - Uncertainty Analysis frequency matrix for 2005

2005		LU	SE	NO	NL	FI	BE	IE	DE	AT	FR	IT	ES	PT	UK	PL	SI	SK	BG	HU	CZ	RO	LT	LV	EE
Rank	1	34.88%	20.18%	5.63%	21.89%																				
Rank	2	18.39%	25.24%	7.78%	36.26%																				
Rank	3	18.48%	29.39%	13.37%	16.24%	8.54%	4.03%		9.42%																
Rank	4	7.42%	9.22%	31.79%	13.23%	14.45%	14.12%		6.38%																
Rank	5	5.38%		15.31%	5.71%	29.02%	19.22%		13.07%																
Rank	6			9.76%		13.68%	18.82%	10.28%	28.29%	11.07%															
Rank	7			11.91%		15.97%	14.42%	17.71%	19.92%	13.27%															
Rank	8					5.07%	7.02%	27.45%	12.86%	35.58%															
Rank	9						5.31%	31.55%	8.41%	31.71%	8.95%														
Rank	10										69.36%		5.18%		7.47%										
Rank	11										15.47%	17.01%	5.42%	45.57%	14.84%										
Rank	12											26.05%	13.25%	23.59%	18.65%		13.17%								
Rank	13											31.95%	21.22%	16.94%	19.67%		6.81%								
Rank	14											12.05%	40.95%	6.25%	22.22%	10.53%	8.00%								
Rank	15											7.01%	9.52%		4.82%	50.06%	28.50%								
Rank	16														9.79%	37.94%	41.93%								
Rank	17																	51.76%		37.67%					
Rank	18																	14.25%	27.25%	32.55%	25.45%				
Rank	19																	23.91%	16.71%	26.36%	25.34%		5.36%		
Rank	20																	5.12%	35.13%		39.06%	5.26%	10.73%		
Rank	21																		10.75%		5.08%	20.20%	45.72%	13.52%	
Rank	22																		7.97%			14.58%	25.60%	44.79%	6.51%
Rank	23																					47.71%	8.72%	24.72%	18.44%
Rank	24																					11.06%		12.25%	72.76%

Figure 5 - Uncertainty Analysis frequency matrix for 2006

2005		LU	SE	NO	NL	FI	BE	IE	DE	AT	FR	IT	ES	PT	UK	PL	SI	SK	BG	HU	CZ	RO	LT	LV	EE
Rank	1	34.88%	20.18%	5.63%	21.89%																				
Rank	2	*18.39%*	***25.24%***	7.78%	*36.26%*																				
Rank	3	18.48%	29.39%	**13.37%**	16.24%	8.54%	4.03%		9.42%																
Rank	4	7.42%	9.22%	*31.79%*	**13.23%**	14.45%	14.12%		6.38%																
Rank	5	5.38%		15.31%	5.71%	***29.02%***	*19.22%*		13.07%																
Rank	6			9.76%		13.68%	**18.82%**	10.28%	*28.29%*	11.07%															
Rank	7			11.91%		15.97%	14.42%	**17.71%**	19.92%	13.27%															
Rank	8					5.07%	7.02%	*27.45%*	**12.86%**	*35.58%*															
Rank	9						5.31%	31.55%	8.41%	**31.71%**	8.95%														
Rank	10										***69.36%***		5.18%		7.47%										
Rank	11										15.47%	**17.01%**	5.42%	*45.57%*	14.84%										
Rank	12											*26.05%*	**13.25%**	23.59%	18.65%		13.17%								
Rank	13											31.95%	*21.22%*	**16.94%**	*19.67%*		6.81%								
Rank	14											12.05%	40.95%	6.25%	**22.22%**	10.53%	8.00%								
Rank	15											7.01%	9.52%		4.82%	***50.06%***	*28.50%*								
Rank	16														9.79%	37.94%	**41.93%**								
Rank	17																	***51.76%***		*37.67%*					
Rank	18																	14.25%	**27.25%**	*32.55%*	25.45%				
Rank	19																	23.91%	*16.71%*	**26.36%**	*25.34%*		5.36%		
Rank	20																	5.12%	35.13%		**39.06%**	5.26%	10.73%		
Rank	21																		10.75%		5.08%	**20.20%**	*45.72%*	13.52%	
Rank	22																		7.97%			14.58%	**25.60%**	*44.79%*	6.51%
Rank	23																					*47.71%*	8.72%	**24.72%**	18.44%
Rank	24																					11.06%		12.25%	***72.76%***

Figure 6 - Uncertainty Analysis frequency matrix for 2007

2007		LU	NL	BE	NO	SE	FI	IE	DE	AT	FR	ES	IT	UK	PL	PT	HU	SI	SK	LT	CZ	BG	LV	RO	EE
Rank	1	43.06%	6.50%	27.20%		11.95%	9.70%																		
Rank	2	*13.05%*	**19.47%**	13.58%	8.91%	24.77%	9.53%				8.39%														
Rank	3	8.22%	7.24%	***19.84%***	13.67%	*21.46%*	18.10%		6.26%																
Rank	4	6.31%	6.21%	20.63%	**15.02%**	17.89%	*21.96%*				6.11%														
Rank	5	5.82%	6.50%	10.08%	*22.39%*	**8.43%**	24.55%		11.74%	5.70%	4.56%														
Rank	6	6.40%	*7.46%*	7.39%	27.54%		**12.74%**		*21.26%*	5.46%	5.29%														
Rank	7	6.26%	6.30%		9.59%			**21.07%**	26.61%	17.17%	5.83%														
Rank	8							*31.45%*	**14.34%**	*26.82%*	*9.48%*														
Rank	9							28.71%	10.29%	**29.54%**	15.66%														
Rank	10		19.81%					14.32%		11.95%	**38.76%**	8.41%													
Rank	11		6.46%									***47.36%***	28.45%			11.48%									
Rank	12											28.76%	***34.64%***	6.11%	8.42%	17.51%									
Rank	13											7.42%	8.69%	**17.38%**	*55.26%*	*10.10%*									
Rank	14												11.23%	*18.56%*	**27.61%**	28.20%	8.07%								
Rank	15													34.33%	7.92%	**31.20%**	7.94%			7.24%	5.65%				
Rank	16																***38.11%***			*37.20%*	12.70%				
Rank	17																39.58%	**10.23%**	6.26%	26.87%	8.15%				
Rank	18																4.26%	*41.22%*	**16.35%**	11.94%	*16.81%*				
Rank	19																	30.66%	19.15%	**6.70%**	25.87%	7.80%			
Rank	20																	9.82%	*41.92%*	7.99%	**14.68%**	*16.89%*			
Rank	21																		13.13%		13.52%	*48.67%*	19.68%		
Rank	22																					22.98%	***69.42%***	12.82%	
Rank	23																						10.84%	***80.31%***	8.00%
Rank	24																							6.51%	***91.89%***

6. Conclusions

As a second step in the process of construction of a set of composite indicators on flexicurity within a joint DG EMPL-JRC project, this paper presents an attempt to calculate a Composite Indicator on Active Labor Market Policies, which is one of the main four dimensions of Flexicurity according to relevant Commission policy documents (see COM(2007) 359). This indicator is based on 16 basic indicators and covers the four year period from 2004 to 2007. It is based on the Eurostat's Labour Market Policies Database. Results point to a heterogeneous Europe, with an overall good performance of Nordic countries, and less favorable scores for Mediterranean and Eastern Member States. The indicator's country ranking is quite stable over the period considered, as countries register only slight differences in their positions from one year to another. Uncertainty and sensitivity analysis have been performed in order to test the robustness of the Composite Indicator. Those were based on 23800 different simulated scenarios, generated by considering different options with respect to standardization methods, weighting scheme, aggregation rules and the inclusion/exclusion of basic indicators. Results show that the composite indicator's scores and rankings are overall robust over the period, although some variability is present in each year. This is mainly due to the imputation of missing data. On average, countries record a higher ranking variability with respect to the Life Long Learning Composite indicator. However, the ALMP index is still quite robust compared to similar indicators developed in the literature and taking into account that the LLL index covers only one year.

7. Bibliography

- Nardo, M., Saisana, M., Saltelli, A., and Tarantola, S. (EC/JRC), Hoffman, A. and Giovannini, E., (OECD). (2005). *Handbook on constructing composite indicators: methodology and user guide* OECD Statistics Working Paper.
- Saltelli, A., Chan,K. And Scott, M.. (2000a). *Sensitivity Analysis*. Probability and Statistics Series. New York: John Wiley & Sons.
- Saltelli, A., Tarantola S. and Campolongo F. (2000b). *Sensitivity Analysis as an Ingredient of Modelling*. Statistical Science 15:377-395.
- Jamison, D. and Sandbu, M. (2001), "WHO ranking of health system performance", Science, 293, 1595-1596.
- Freudenberg, M. (2003), Composite indicators of country performance: a critical assessment, OECD, Paris.
- Tarantola S., Jesinghaus J. and Puolamaa M. (2000), Global sensitivity analysis: a quality assurance tool in environmental policy modelling. In Sensitivity Analysis (eds Saltelli A., Chan K., Scott M.) pp. 385- 397. New York: John Wiley & Sons.
- European Commission (2001a), Summary Innovation Index, DG Enterprise, European Commission, Brussels.
- World Economic Forum (2002), Environmental Sustainability Index. http://www.ciesin_org/indicators/ESI/index.html.
- Fagerberg J. (2001), Europe at the crossroads: The challenge from innovation-based growth in the Globalising Learning Economy, B. Lundvall and D. Archibugi eds., Oxford Press.
- Saltelli A. (2002), Making best use of model valuations to compute sensitivity indices, Computer Physics Communications, 145, 280-297.
- Saltelli, A., Ratto, M., Andres, T., Campolongo, F., Cariboni, J., Gatelli, D. Saisana, M., Tarantola, S., (2008) , *Global Sensitivity Analysis. The Primer*, John Wiley & Sons publishers.
- Mascherini, M. “Towards a set of composite indicators on Flexicurity: The Composite indicator on Active Labour Market Policies” EUR REPORT 23516 EN.-
- Little R.J.A. and Schenker N. (1994), Missing Data, in Arminger G., Clogg C.C., and Sobel M.E.(eds.) Handbook for Statistical Modeling in the Social and Behavioral Sciences, pp.39-75, New York:Plenum.
- Little R.J.A (1997), Biostatistical Analysis with Missing Data, in Armitage P. and Colton T. (eds.) Encyclopaedia of Biostatistics, London: Wiley.
- Little R.J.A. and Rubin D.B. (2002), Statistical Analysis with Missing Data, Wiley Interscience, J. Wiley& Sons, Hoboken, New Jersey.
- Gilks, W. R., Richardson, S. and Spiegelhalter, D. J. (1996) Markov Chain Monte Carlo in Practice, Chapman and Hall, London
- Schafer J.L. (1999), Multiple imputation: a primer, Statistical Methods in Medical Research, Vol. 8, No. 1, 3-15.
- Rubin,D.B. and Schenker N. (1986), Multiple imputation for interval estimation from simple random samples with ignorable nonresponse - Journal of the American Statistical Association, Vol. 81, No. 394 (Jun., 1986), pp. 366-374

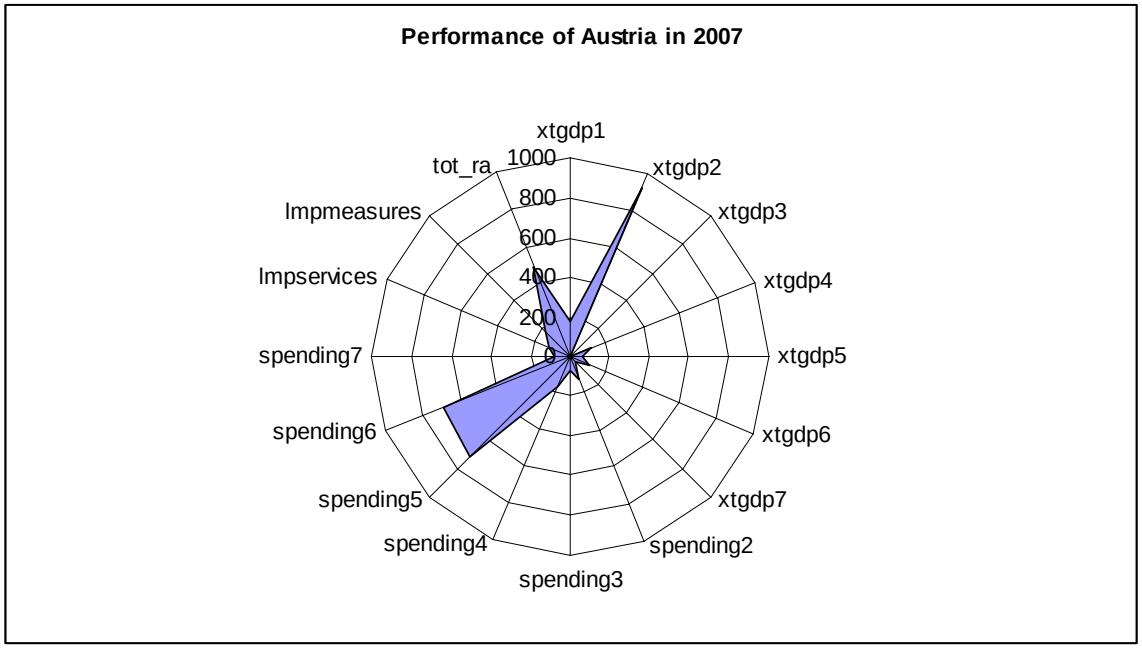
ANNEX 1: COUNTRY PROFILES

Country Profiles

In this section we analyse the country profiles for the 16 basic indicators of the Effective Active Labour Market Policies Composite Indicator and the robustness of the ranking achieved by the country 2004, 2005, 2005, 2006 and 2007. In order to ensure the comparability of the performances, the normalized values of the set of basic indicators is represented using a radar plot, where the higher is the value of the indicator, the best is the performance of the country in that indicator. We decided to present the radar plot for each country only for 2007 in order to make easier the reading of this report. The basic indicators are listed using their short name, for the complete name please see table 1. In addition the robustness of the ranking performance of the country in each year is presented with the results of the uncertainty and sensitivity analysis.

Austria

In 2007 Austria is ranked in the 9th position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. Austria performs quite well in different indicators like " *Spending per participant in supported employment and rehabilitation*" and "*Spending per participant in Direct job creation"*. It has a good performance also in "*LMP expenditure by Training*". On other hands a bad performance for Austria is recorded for "*LMP expenditure in Start-up incentives*".



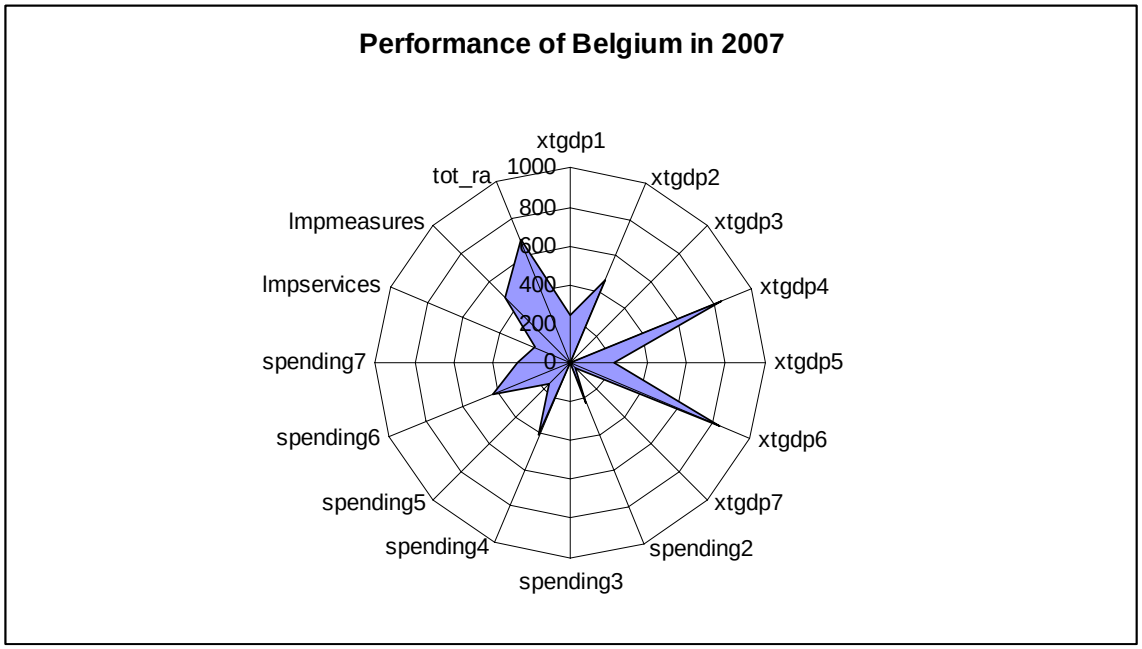
Across the four years Austria maintains its position between the 7th , in 2006, and the 9th in 2005 and 2007. In 2004 the ranking of Austria is quite good, the median of the distribution of the 23800 simulations correspond to the position in the ranking of the AMLP composite indicator. On other hands the mode of the distribution is on position 10th. The ranking of Austria varies from the 6th position to the 10th position but most of the observations and the distribution in this range is bimodal in the 7th and 10th position.

AT	Rank	Rank	Rank	Rank	Rank	Rank
	5	6	7	8	9	10
2004		14.74%	25.14%	***17.96%***	8.59%	28.24%
2005	5.44%	11.07%	13.27%	*35.58%*	**31.71%**	
2006	18.42%	*23.05%*	**18.57%**	14.17%	15.58%	4.59%
2007	5.70%	5.46%	17.17%	*26.82%*	**29.54%**	11.95%

In 2005 the performance of Austria is better than 2004 because it is in the 9th position. Most of observations (80%) are concentrated between the 7th and the 9th position. The distribution is bimodal in the 8th and the 9th position and the other hands the median of the distribution is in the 8th position. The rank of Austria in 2006 is worse than the previous years in fact it ranks in the 7th position. Its rank varies from the 5th to the 9th position but most of the observations are concentrated between the 5th and the 7th , on the other hands the median and the mode are in the 6th position. In 2007 Austria reach the best performance in the 9th position. In this year the ranking varies between the 7th and the 10th position, the mode corresponds to the position of the indicator while the median is in the 8th position.

Belgium

In 2007 Belgium is ranked in the 3rd position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. Belgium performs quite well in the "*LMP expenditure by Direct job creation"* and in the "*LMP expenditure in Employment incentives*" were for both the first position is achieved. On other hands a bad performance for Belgium is recorded for the spending in training and for the LMP expenditure in start up incentives.



In the fourth years Belgium varies from the 1st position to the 8th maintaining the 6th position from the 2004 until the 2006 and recorded the best performance in 2007 when the country is ranked in the 3rd position. In 2004 the performance of Belgium is quite robust, its ranking varies between the 2nd and the 8th position, but between the 4th and the 6th position most of the observations (65%) are concentrated. The median and the mode of the distribution of the 23800 simulations correspond to the 4th position in the ranking of the AMLP composite indicator. In 2005 the position ranked by Belgium is still the 6th, but the indicator varies in a bigger range (from the 1st to the 9th position). On other hands the median and the mode of the distribution is on position 5th.

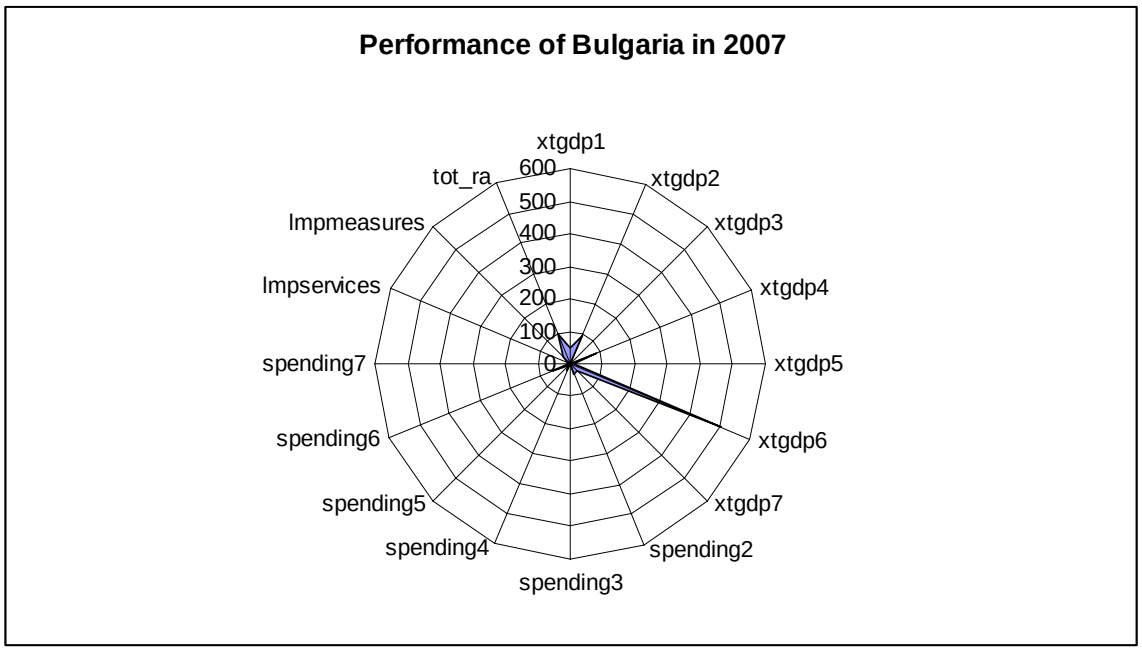
BE	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
	1	2	3	4	5	6	7	8	9
2004		5.87%	14.08%	*28.92%*	17.85%	**18.34%**	7.64%	3.16%	
2005	9.92%	7.11%	4.03%	14.12%	*19.22%*	**18.82%**	14.42%	7.02%	5.31%
2006	11.61%	8.23%	7.16%	*29.92%*	12.66%	**9.03%**	9.38%	10.54%	
2007	27.20%	13.58%	***19.84%***	20.63%	10.08%	7.39%			

The performance of Belgium in 2006 is still in the 6th position, although in this position there are less than 10% of observations: this result is determined by the assumption we made on the weights we adopted. In 2006 the indicator varies from the 1st to the 8th position, although most of the observations are focused between the 4th and the 6th position. The median and the mode of the distribution are both in the 4th position. In 2007

Belgium reaches its best performance ranking the top the league in 3rd position with a frequency of almost 20% of observations (19.84%). The mode and the median are both in the 4th position.

Bulgaria

Across the four years Bulgaria is ranked in the 18th position from 2004 to 2006 while in 2007 the country has a worse performance ranking in 21st position of the overall ranking. Bulgaria performs not well in many of the basic indicators of the Effective Active Labour Market Policies Composite Indicator. The best result of Bulgaria is achieved for the basic indicator of "*LMP expenditure in direct job creation* where the 2nd position is achieved.



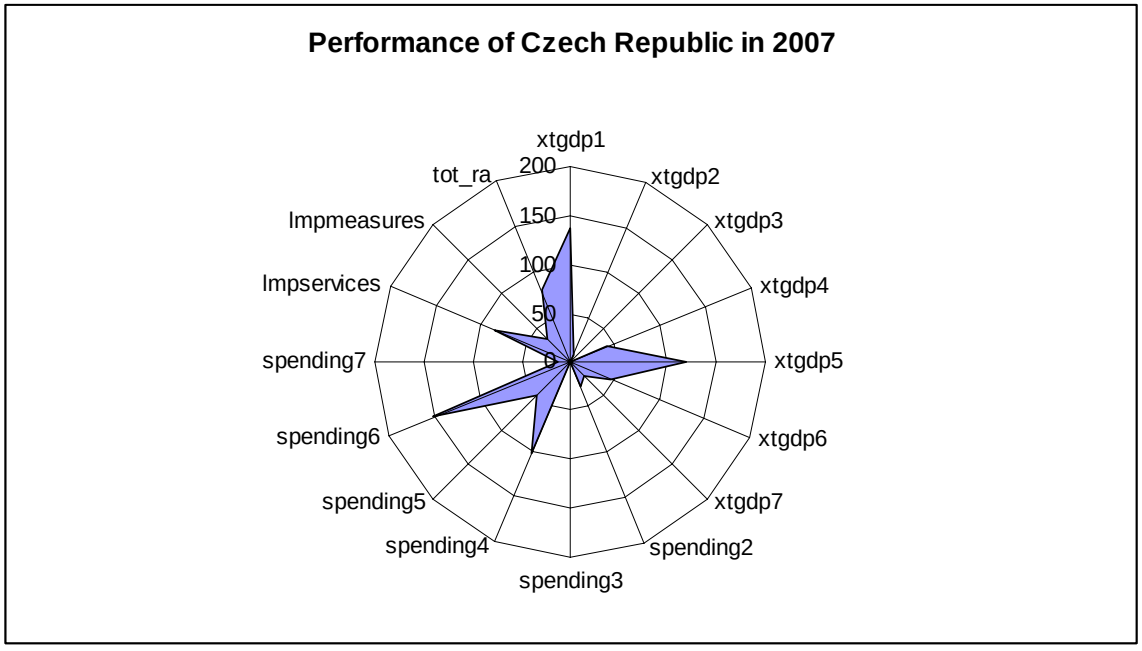
On the whole the performance of Bulgaria is robust in the uncertainty analysis: in 2004 the performance of this country varies from the 16th to the 18th position where 97% of observations are concentrated. The median and the mode correspond to the position of the country achieved in the AMLP composite indicator (18th). In 2005 the country still ranks in 18th position with a frequency of 27% of observations. On the other hands the median and the mode fall in the 20th position.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
BG	16	17	18	19	20	21	22	23
2004	23.09%	17.30%	***56.86%***	2.09%	0.66%			
2005		1.73%	**27.25%**	16.71%	*35.13%*	10.75%	7.97%	
2006			**22.55%**	3.46%	3.53%	*18.38%*	38.99%	12.37%
2007			2.21%	7.80%	*16.89%*	**48.67%**	22.98%	

In 2006 Bulgaria maintains its 18th position among the 23800 performed simulations. On the other hands the median falls in the 18th position while the mode in the 22nd. In 2007 the performance of Bulgaria is worse (21st position) and varies between the 20th to the 22nd position. The median falls in the 20th position while the mode correspond to the position of the AMLP composite indicator.

Czech Republic

Across the four years Czech Republic is ranked between the 18th to the 21st position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. This performance is driven by the performance in the basic indicators of *"LMP expenditure in Labour market services"* , *"LMP expenditure in supported employment and rehabilitation" and "Spending per participant indirect job creation"*.
On other hands, a bad performance is recorded for the indicators of *Spending per participant in job sharing and job rotation"*



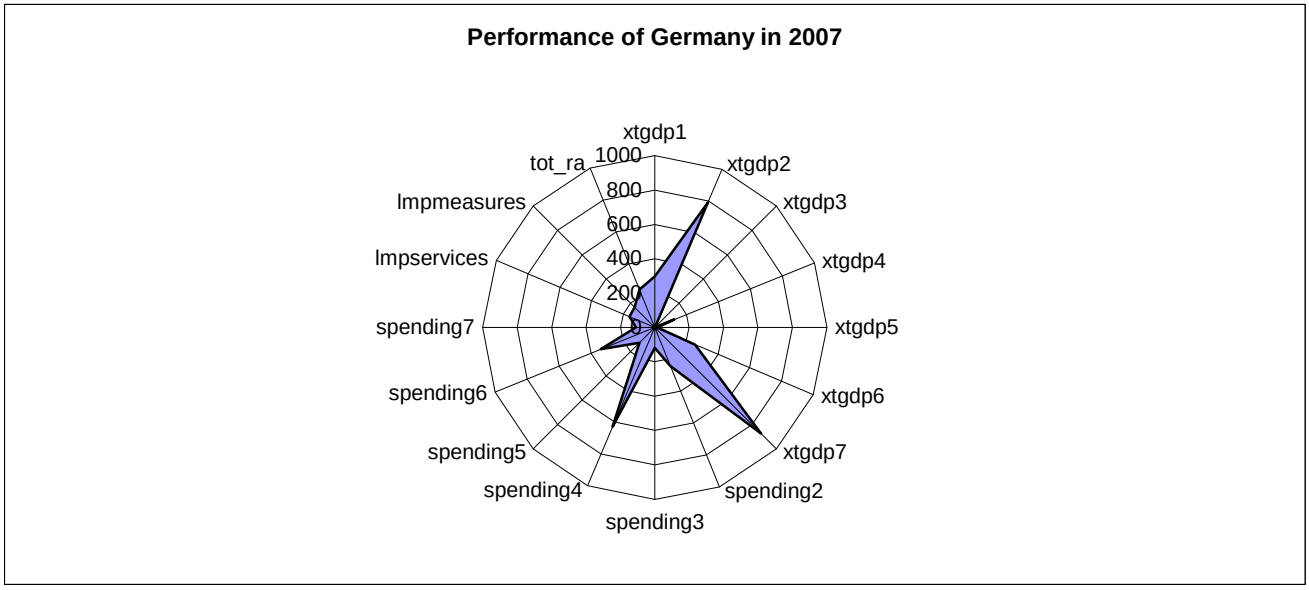
The performance of Czech Republic in the uncertainty analysis is quite robust. In 2004 the performance of Czech Republic ranks the 18th position. The indicator varies from the 16th to the 18th position where are concentrated the 93% of the observations. On the other hands the mode and the median of the indicator fall both in the 17th position. In 2005 Czech Republic performs worse than in 2004 ranking in 20th position with a frequency of 39% among 23800 performed simulations. The mode corresponds with the ranking recorded in the AMLP composite indicator. In this year the variation of the indicator is concentrated between the 18th and the 20th position. On the other hands the median falls in the 19th position.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
CZ	13	14	15	16	17	18	19	20	21
2004			6.18%	15.99%	*38.84%*	**38.76%**			
2005				0.09%	4.94%	25.45%	*25.34%*	**39.06%**	5.08%
2006					14.36%	*27.42%*	27.27%	20.31%	**6.44%**
2007			5.65%	12.70%	8.15%	*16.81%*	25.87%	**14.68%**	13.52%

In 2006 the performance of Czech Republic is the worst recorder in the four years: the country ranks the 21st position. The median and the mode are both in the 18th position. In 2007 Czech Republic ranks the 20th position while the mode corresponds with the 19th position and the median falls into the 18th position. In 2007 the AMLP composite indicator for Czech Republic varies from the 18th to the 21st position.

Germany

From 2004 to 2007 Germany ranks from the 5th to the 9th position recording a good performance. Compared with that of the other central European countries. In 2007 Germany achieved the 8th position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. As figure below shows the radar plot for the 2007 the good performance of Germany is driven by different indicators. In particular the "*LMP expenditure in training*" and the "*LMP expenditure in start-up incentives*" record the best performances which respectively have the 3rd and the 5th position. On other hands, in terms of score, the worse performance is recorder for *"LMP expenditure in job sharing and job rotation"*.



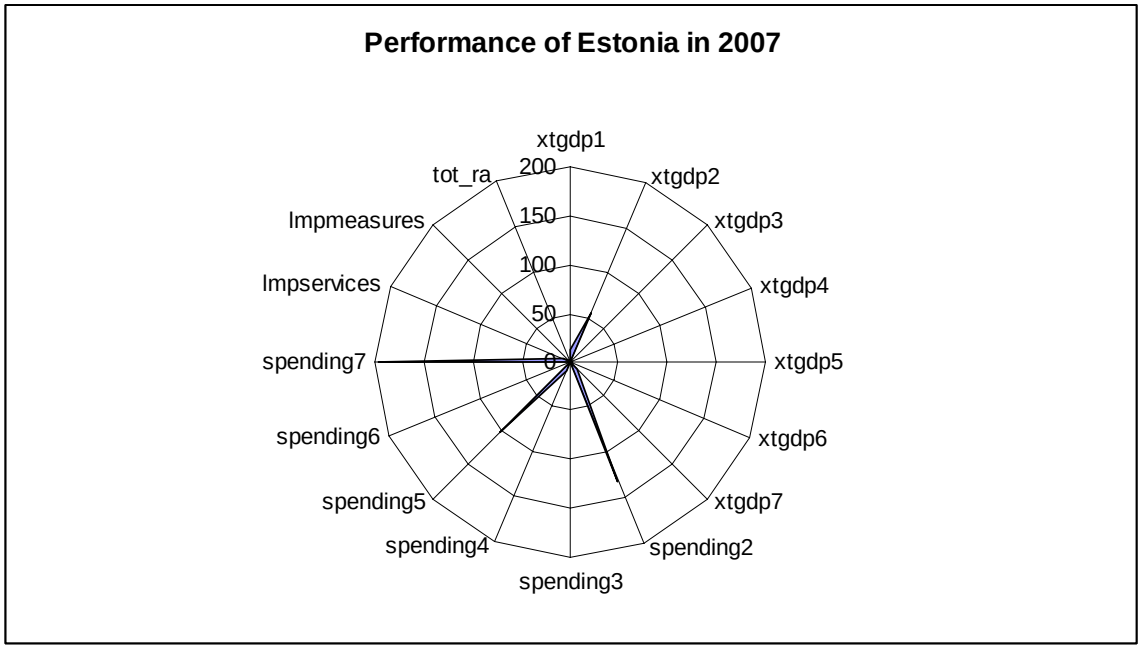
The performance of Germany in the uncertainty analysis shows a considerable variability in the ranking positions across all the three years. In 2004 Germany performance varies from the 1st to the 6th, and rank the 5th position with almost 30% of frequency among 23800 performed simulations. The mode corresponds to the position recorder in the AMLP indicator , while the median falls in the 4th position. In 2005 Germany performed worse ranking in 8th position. The observations are spread from the 3rd to the 8th position. On the other hand the mode and the median fall in the 6th position..

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
DE	1	2	3	4	5	6	7	8	9
2004	10.35%	19.69%	13.94%	*12.85%*	**29.81%**	10.05%			
2005			9.42%	6.38%	13.07%	*28.29%*	19.92%	**12.86%**	8.41%
2006				5.21%	11.17%	12.82%	9.98%	***20.38%***	33.87%

In 2006 the 8th position of the AMLP composite indicator is maintained with a frequency of almost 20% of observations among 23800 simulations. The mode falls in the 9th position while the median corresponds to the position recorded for the AMLP composite indicator

Estonia

Across the four years Estonia performance ranks from the 21st to the 24th position of the overall ranking. Figure below shows the radar plot for 2007. The Estonia performance is driven by the "S*pending per participant in training"* where the 9th position is achieved, the "*Spending per participant in start-up incentives"* where the country is ranked at the 6th position. On other hands, the worse result is obtained for the indicators of "*LMP expenditure in employment incentives "* where the last position is reached.



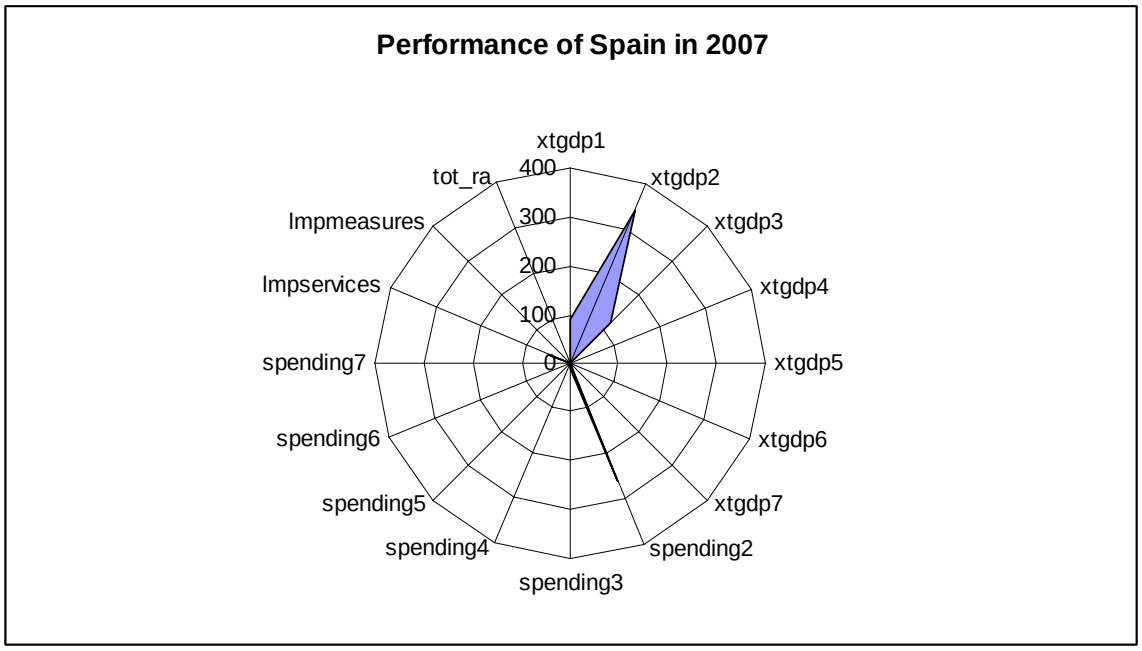
The performance of Estonia is indubitably very robust and stable especially for 2006. In 2004 Estonia ranks the 21st position with almost 25% of frequency among 23800 performed simulations. The mode falls in the 22nd position while the median corresponds to the ranking position of the AMLP composite indicator. In 2005 Estonia performed worse than in 2004 falling in the 24th position with a frequency of 72% of observations. The mode and the median correspond with the position of the composite indicator.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank
EE	18	19	20	21	22	23	24
2004		8.43%	24.91%	***23.82%***	42.30%		
2005					6.51%	18.44%	***72.76%***
2006							***99.83%***
2007						8.00%	***91.89%***

In 2006 and 2007 Estonia maintain the 24th position where respectively 99% and 91% of observations are focused. The median and the mode correspond to the ranking position of the AMLP composite indicator both for 2006 and 2007.

Spain

Spain ranks from the 12th to the 11th position across 2004 to 2006. Among the Southern European countries, Spain has a good position. Spain performance is driven by "*LMP expenditure in training"* the "*LMP expenditure in labour market services*" and " *LMP expenditure in job sharing and job rotation*" where the 7th , the 10th and the 3rd position are respectively achieved.



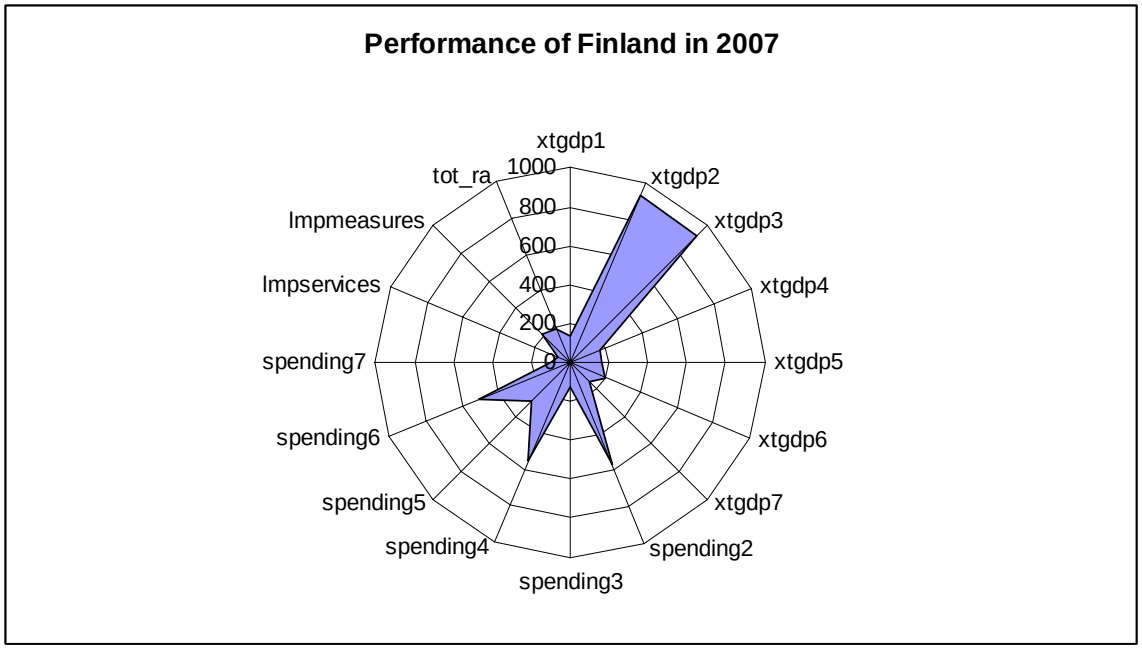
The performance of Spain in the uncertainty analysis is quite robust. In 2004 Spain ranks the 12th position with almost 26% of frequency of observations among 23800 performed simulations. Spain has a range of variation between the 11th where there are 49% of the observations among 23800 performed simulations and the 13th position. On the other hand the median and the mode fall both in the 11th position.

	Rank	Rank	Rank	Rank	Rank	Rank
ES	9	10	11	12	13	14
2004	0.05%	0.93%	*49.26%*	**25.95%**	21.55%	2.26%
2005	0.39%	5.18%	5.42%	**13.25%**	*21.22%*	40.95%
2006	0.86%	11.45%	***39.91%***	29.86%	10.33%	5.05%
2007	3.97%	8.41%	***47.36%***	28.76%	7.42%	2.14%

In 2005 Spain maintain the rank in the 12th position while the median fall in the 13th position and the mode in the 14th. In 2006 the Spain performance is better ranking the 11th position which corresponds to the median and mode of the distribution. The same performance is recorded also in 2007 where mode and median are recorded in the 11th position which corresponds to the position recorded in the AMLP composite indicator.

Finland

From 2004 to 2007 Finland ranks from the 5th to the 7th position recording a very good performance. The best performance of this country is achieved in the indicator of *"LMP expenditure in training"* and in *"LMP expenditure in job sharing and job rotation"* where it is ranked at the 1st position for both the indicators. . On other hands, in terms of ranking, Finland worst performance is recorded for the dimension of *"LMP services"* where the 10th position is achieved.



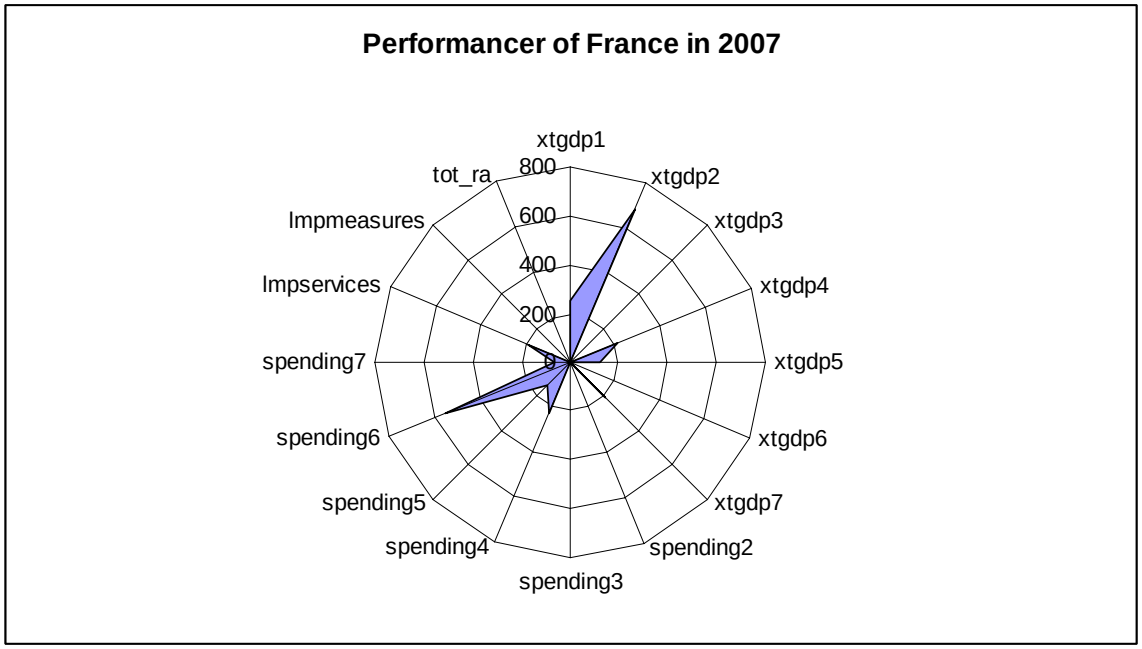
The performance of Finland is robust as confirmed in the sensitivity analysis. In 2004 Finland is ranked in the 7th position with a frequency of almost 17% of observations among 23800 simulations. The median corresponds to the position of the AMLP composite indicator, while the mode of the distribution correspond to the 9th position. In 2004 the variability of Finland is spread from the 5th position to the 10th although 64% of observations are concentrated between the 7th and the 9th position. In 2005 Finland performs better than in 2004 ranking the 5th position with 29% of frequency of observations. The mode and the median fall in the position recorded in the AMLP composite indicator.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
FI	3	4	5	6	7	8	9	10
2004			7.26%	8.85%	***16.98%***	23.29%	24.67%	11.63%
2005	8.54%	14.45%	***29.02%***	13.68%	15.97%	5.07%		
2006	9.59%	16.38%	***19.48%***	16.07%	15.04%	7.87%		
2007	18.10%	21.96%	*24.55%*	**12.74%**				

In 2006 Finland maintain its 5th position as in 2005 with the same range of variability of 2005. In 2007 Finland performs slightly better ranking the 6th position. On the other hand the mode and the median fall both in the 5th position.

France

The performance of France is very robust and stable in fact it ranks always the 10th position across the four years of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. The France performance is driven by "*LMP expenditure in training"* and by "*Spending per participant in direct job creation"* where the 2nd and the 7th position is respectively achieved. On other hands, a not good performance is recorded by France for the dimension of "*LMP expenditure in start-up incentives"* where France ranks the 4th position. The "*Spending per participant in job sharing and job creation*" and the " *LMP expenditure in job sharing and job creation*" is not measured.



The performance of France is quite stable across the 2004, 2005, 2006 and 2007. Although the position of the country varies from the 7th to the 10th position in 2004, it is

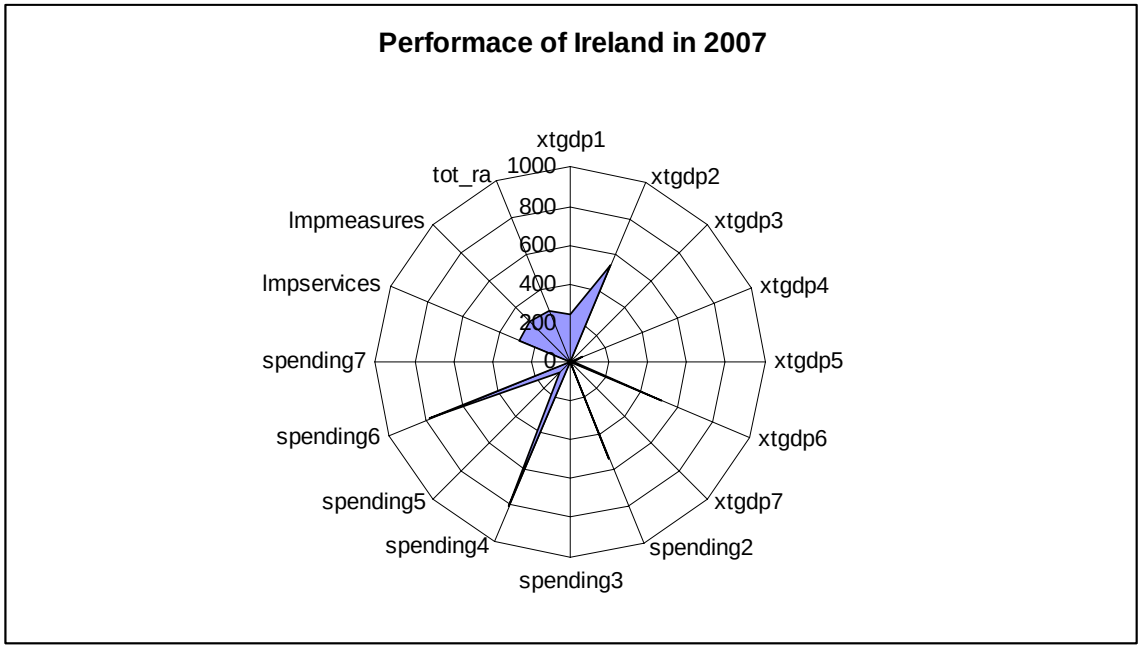
worth noticing that the 51% of the simulations fall between the 9th and the 10th position. The median of the distribution of the 23800 simulations falls in the 9th position while the mode corresponds with the position recorded in the AMLP composite indicator. In 2005 France still maintain the 10th position with a frequency of 69% of the observation. The mode and the median fall in the position of the AMLP composite indicator.

	Rank	Rank	Rank	Rank	Rank	Rank
FR	6	7	8	9	10	11
2004		12.26%	19.77%	*20.86%*	**31.05%**	
2005				8.95%	***69.36%***	15.47%
2006			5.16%	13.39%	***63.15%***	11.11%
2007	5.29%	5.83%	9.48%	15.66%	***38.76%***	

In 2006 as in 2007 the 10th position is still maintained. On the other hand for both years the mode and the median fall in the position of the AMLP composite indicator. By the way in 2007 the performance of France varies from the 6th to the 10th position even if 54% of the observations are focused between the 9th and the 10th position.

Ireland

The performance of Ireland across the four years is good. Ireland has the best performance between the Anglo-Saxon countries of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. Across the four years Ireland ranks frm the 7th to the 9th position. As shown in figure below in 2007 the good performance of Ireland is characterized by some basic indicators like "*Spending per participant in employment incentives*" and "*Spending per participant in direct job creation*" where the country is in the 2nd in both the indicators. On the other hands the "*LMP expenditure in supported employment and rehabilitation*" records a bad performance where the country has the 13th position.



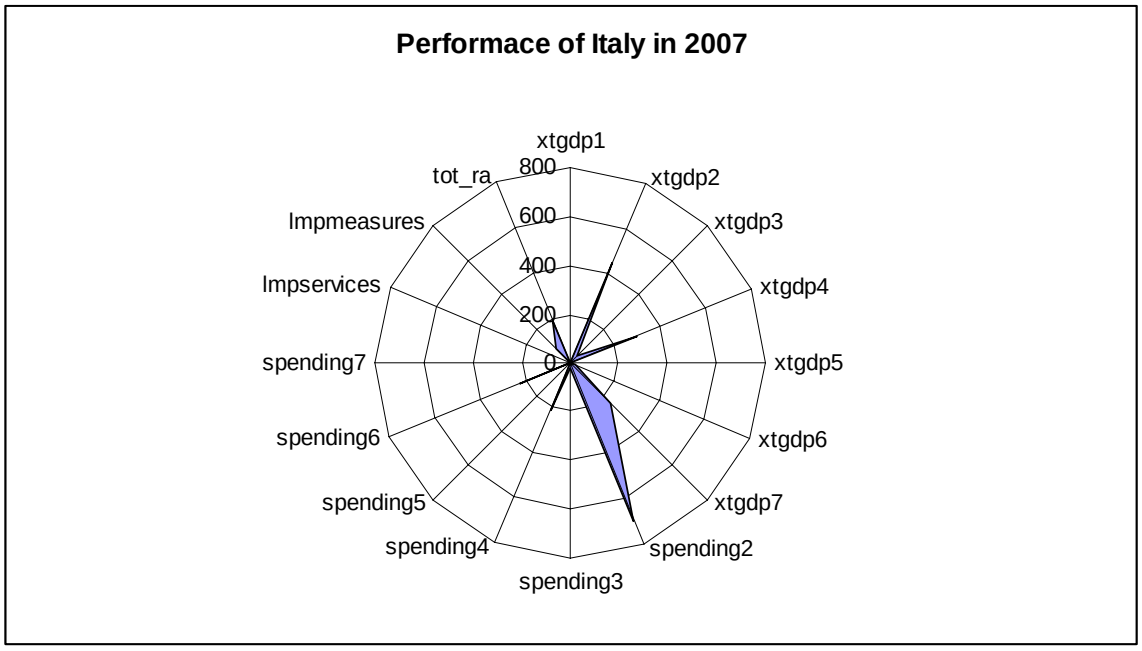
The performance of Ireland is robust in the uncertainty analysis and from 2004 to 2007 the position of the country varies from position 5th to 10th position and the frequencies of the simulations are spread among these position. In 2004 Ireland ranks the 9th position with 32 % of observations among the 23800 performed simulations. On the other hands the median falls in the 8th position, while the mode corresponds with the position recorded in the AMLP composite indicator. In 2005 Ireland has a better performance ranking the 7th position. On the other hands the mode corresponds to the 9th position while the median is in 8th position. In 2006 Ireland ranks slightly worse respect the 2005; in fact it is in 8th position. The median and the mode are both in 7th position.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
IE	4	5	6	7	8	9	10	11
2004				20.67%	*23.67%*	**32.75%**	17.35%	
2005			10.28%	**17.71%**	*27.45%*	31.55%		
2006		6.81%	15.59%	*24.66%*	**21.89%**	20.53%	6.24%	
2007				**21.07%**	*31.45%*	28.71%	14.32%	

In 2007, as in 2004, Ireland records the best performance reaching the 7th position. On the other hand the 8th position corresponds with the median and the mode of the distribution of the AMLP composite indicator.

Italy

Across the four years Italy has the best performance among the Mediterranean countries. From 2004 to 2007 Italy ranks from the 11th to the 12th position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. . This good performance is driven by a top performance in the basic indicators of "*Spending per participant in training*" which leads the country to the 3rd position. On the other hand Italy records a bad performance in "*Spending per participant in direct job creation*" where the country is in 9th position.



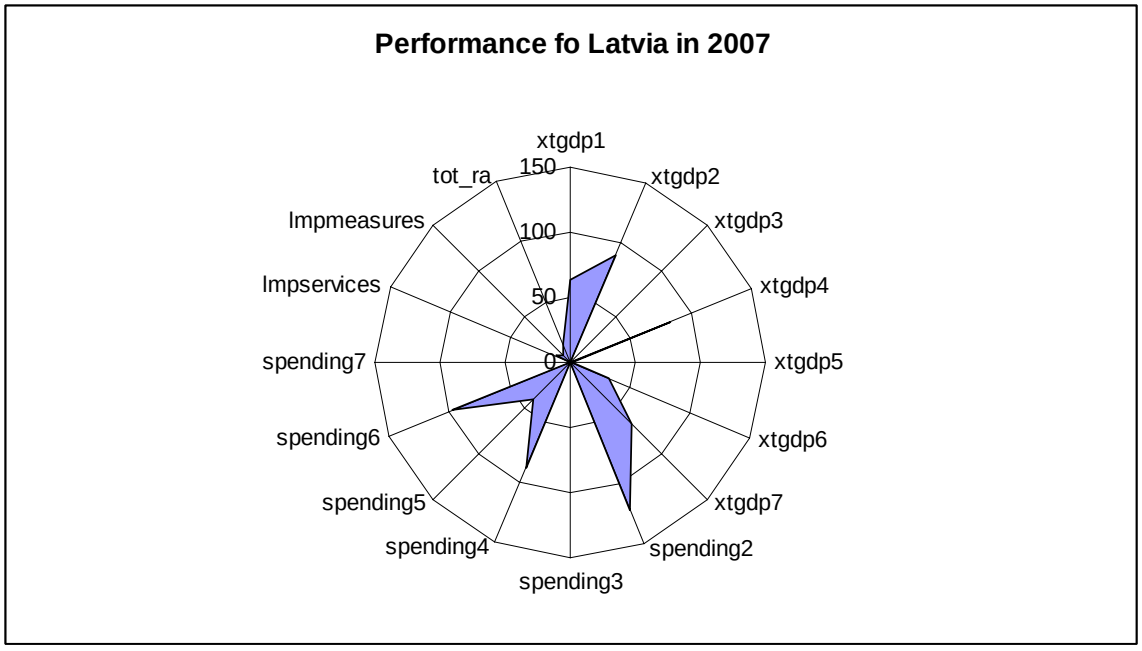
The performance of Italy in the uncertainty analysis is quite robust and stable. In 2004 Italy ranks the 11th position which is maintained also in 2005. On the other hand in 2004 the median and the mode correspond with the 12th position. In 2005 the country performance varies from the 10th to the 14th position with the median in the 12th position and the mode in 13th.

	Rank	Rank	Rank	Rank	Rank	Rank
IT	10	11	12	13	14	15
2004		**23.09%**	*48.43%*	23.45%	4.90%	
2005	3.50%	**17.01%**	*26.05%*	31.95%	12.05%	7.01%
2006		3.07%	**37.03%**	*34.29%*	17.89%	4.05%
2007		28.45%	***34.64%***	8.69%	11.23%	4.28%

In 2006 Italy performs slightly worse ranking the 12th position with 37% of frequency of observations among 23800 performed simulations. The median is in the 13th position while the mode corresponds with the position recorded in the AMLP composite indicator. In 2007 Italy ranks still the 12th position like in 2006. The media and the mode fall both in the position of the AMLP composite indicator.

Latvia

Across the four years the performance of Latvia is not good and the country is ranked from the 22nd to the 23rd position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator: Latvia is the worst among the Eastern European Countries. Anyway, Latvia best performance is achieved for the dimension of *"Spending per participant in training;"*, where the country achieves a surprisingly 13th position. By the way a bad performance is recorded for the indicator of *"LMP expenditure in training"* where the country is ranked at the 16th position.



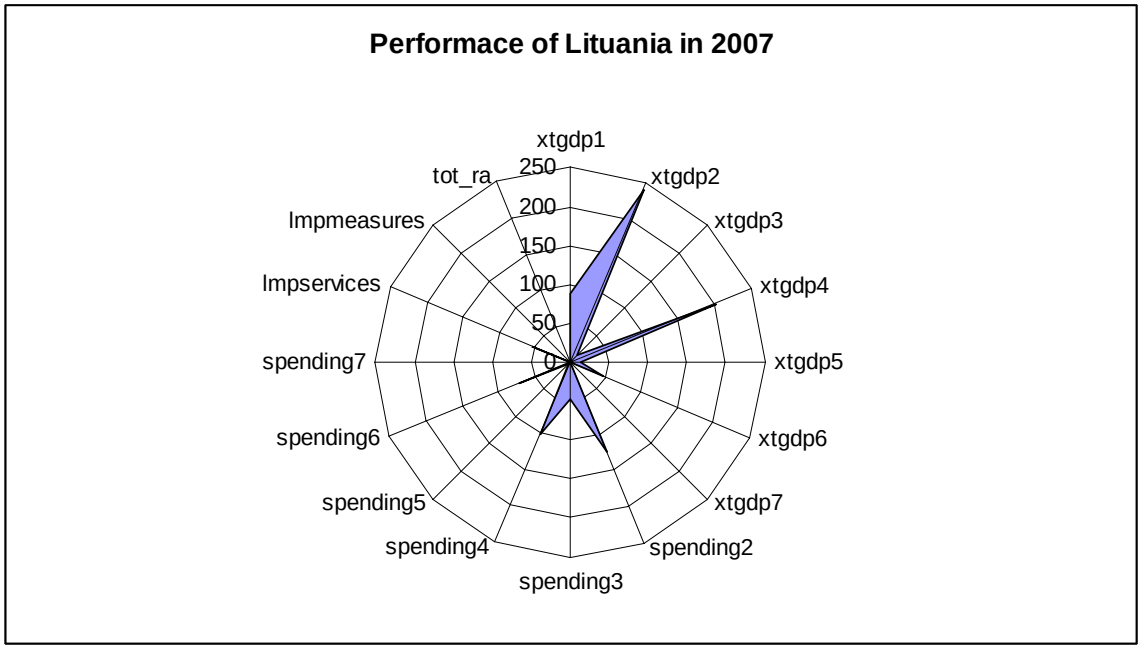
The performance of Latvia in the uncertainty analysis is quite robust and stable. In 2004 the 48% of the simulations falls in the 23rd position of the ranking. The position of Latvia varies from the 19th to the 23rd position. The median falls in the 22nd position while the mode of the distribution of the simulations corresponds the position achieved by Latvia in the AMLP composite indicator in 2004. In 2005 Latvia maintains its 23rd position as in 2004. On the other hands the mode and the median fall both in the 22nd position where are focused the 44% of the observations.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank
LV	18	19	20	21	22	23	24
2004		0.05%	0.29%	17.24%	*34.04%*	**48.38%**	
2005		1.24%	3.47%	13.52%	*44.79%*	**24.72%**	12.25%
2006	3.79%	4.94%	13.61%	*28.55%*	**31.74%**	16.63%	
2007	0.02%	1.92%	2.97%	19.68%	***63.42%***	10.84%	1.14%

In 2006 Latvia performs better its rank reaching the 22nd position. The country varies from the 19th to the 23rd position but most of the observations are concentrated between the 21st and the 22nd position. On the other hand the median falls in the 21st position while the mode corresponds to the AMLP composite indicator rank. In 2007 Latvia confirms its 22nd position with 63% of the frequency of the observations among 23800 performed simulations. The mode and the median corresponds both to the AMLP composite indicator position.

Lithuania

Across 2004 to 2007 Lithuania is ranked from the 19th to the 22nd position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. In 2007 as shown in the figure below the best performance achieved by Lithuania is in the indicator of *"LMP expenditure in training;"* where the country is ranked at the 12th position. A good performance in terms of score is also achieved for the indicator of *"LMP expenditure in employment incentives"*.



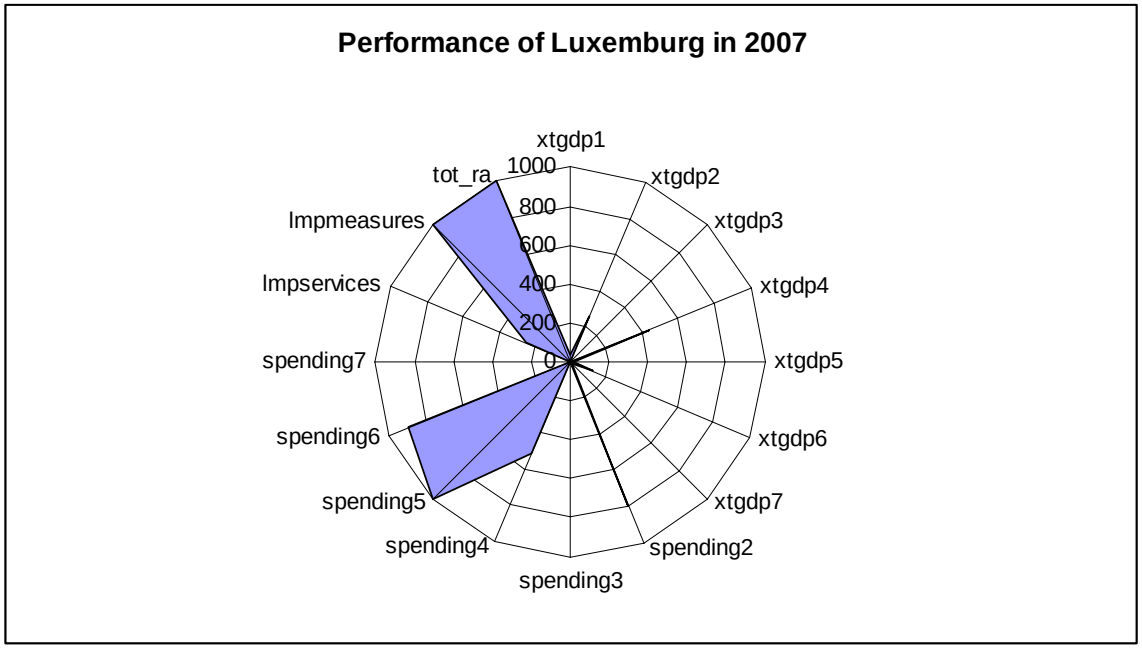
The performance of Lithuania analysis is not very robust and is one of the countries showing a consistent variability in ranking. In 2004 the country is ranked in the 20th position with a frequency of 35% of observations among the 23800 performed simulations. The median and the mode of the distribution correspond to the 20th position which is the position achieved by the country in the AMLP composite indicator. In 2005 Lithuania still maintains the 20th position but with 10% of the observations. This result is due by the weights assumption we made in the building of the AMLP composite indicator. On the other hand the mode and the median fall both in the 21st position.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank
LT	16	17	18	19	20	21	22
2004			0.27%	35.43%	***35.53%***	27.31%	1.46%
2005				5.36%	**10.73%**	*45.72%*	**25.60%**
2006	1.86%	3.28%	9.88%	27.30%	***29.21%***	26.20%	2.19%
2007	37.20%	*26.87%*	11.94%	**6.70%**	7.99%		

In 2006 Lithuania performed slightly better ranking the 20th position. The mode corresponds to the 19th position while the median falls in the same position of the AMLP composite indicator. In 2007 Lithuania ranks the 19th position recording its best performance even if with less than 10% of the observation of the distribution. The median falls in the 17th position, while the mode in the 16th.

Luxembourg

Across 2004 to 2007 Luxembourg is the best top performers of the overall ranking of the Effective Active Labour Market Policies Composite Indicator with an achieved 1st position in each year. In 2007 as shown in the figure below the performance of Luxembourg is mainly driven by top performances in the dimensions of "*Total regular activation*" , as in the "*LMP measures*", in "*Spending per participant in direct job creation and supported employment and rehabilitation*" where the country reaches the 1st position for the first three indicators and the 5th position for the "spending_5". On other hand, Luxembourg worst performance is achieved for the dimensions of "*LMP expenditure in training* " where the 10th position is achieved.



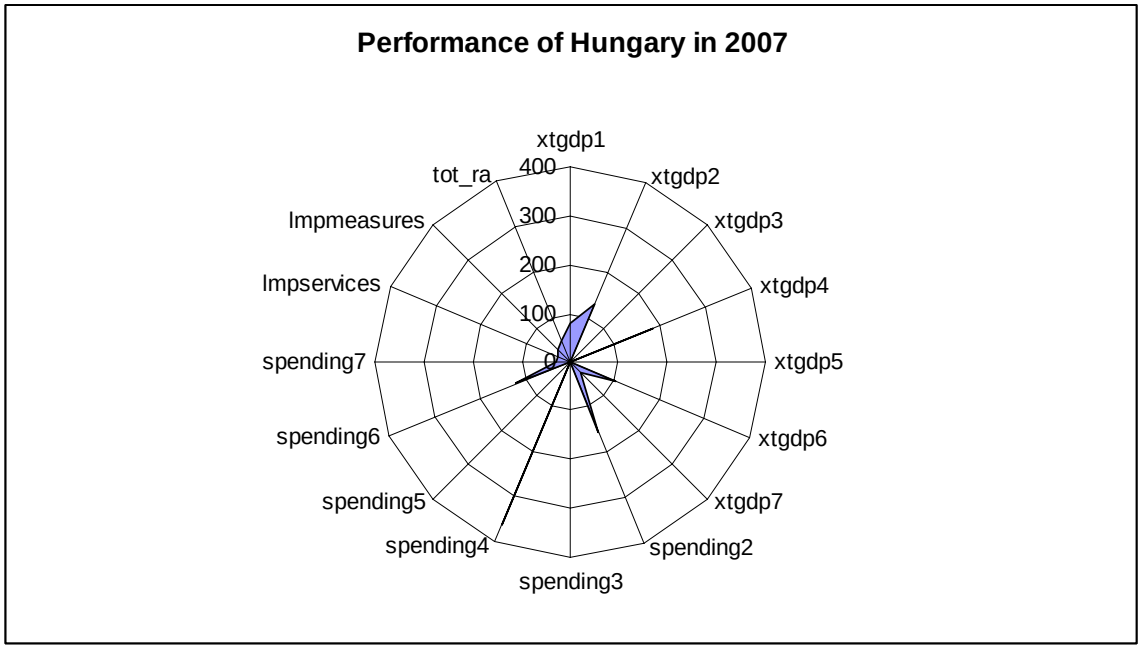
The position of Luxembourg in the uncertainty analysis is stable without any variations in the rankings across the four years. By the way in 2004, 40% of the frequencies of the observations among the 23800 performed simulations are recorded in the 1st position. The median and the mode of the distribution are recorded in the 1st position which corresponds to the position recorded in the AMLP composite indicator. In 2005 the Luxemburg performance maintains the 1st position with the 34% of the observations concentrated in this rank. On the other hand the median falls in the 2nd position while the mode corresponds to the position of the AMLP composite indicator.

	Rank	Rank	Rank	Rank
LU	1	2	3	4
2004	***40.01%***	16.83%	10.94%	10.12%
2005	**34.88%**	*18.39%*	18.48%	7.42%
2006	**25.98%**	*23.79%*	23.61%	10.42%
2007	***43.06%***	13.05%	8.22%	6.31%

In 2006 the excellent performance of Luxemburg is still confirmed by the 1st position in the ranking. The variability of the country is between the 1st and the 4th position, but the 45% of the observations are concentrated in the first two positions. O the other hand the median falls in the second position and the mode in the 1st, which correspond to the position of the AMLP composite indicator. In 2007 Luxemburg conform again its 1st position with 43% of the observations. The mode and the median correspond to the position of the AMLP composite indicator.

Hungary

The performance of Hungary is one of the best among the Easter European Countries and across the four years the country is ranked from the 16th to the 19th position of the overall score. In 2007 as shown in the figure below the performance of Hungary is driven by a good performance in the dimension of "*LMP expenditure in training"* and "*Spending per participant in training"*. On other hands, Hungary worst performance is recorded for the dimension of "*Spending per participant in supported employment and rehabilitation "*,.



The position of Hungary is quite stable as confirmed by the uncertainty analysis. In 2004 Hungary performs the 17th position. The country varies from the 15th to the 17th position, even if the 93% of the observations are focused from the 16th to the 17th position. The median and the mode of the distribution fall in the 16th. In 2005 Hungary performs worse than in 2004 ranking the 19th position. The mode and the median fall both in the 17th position.

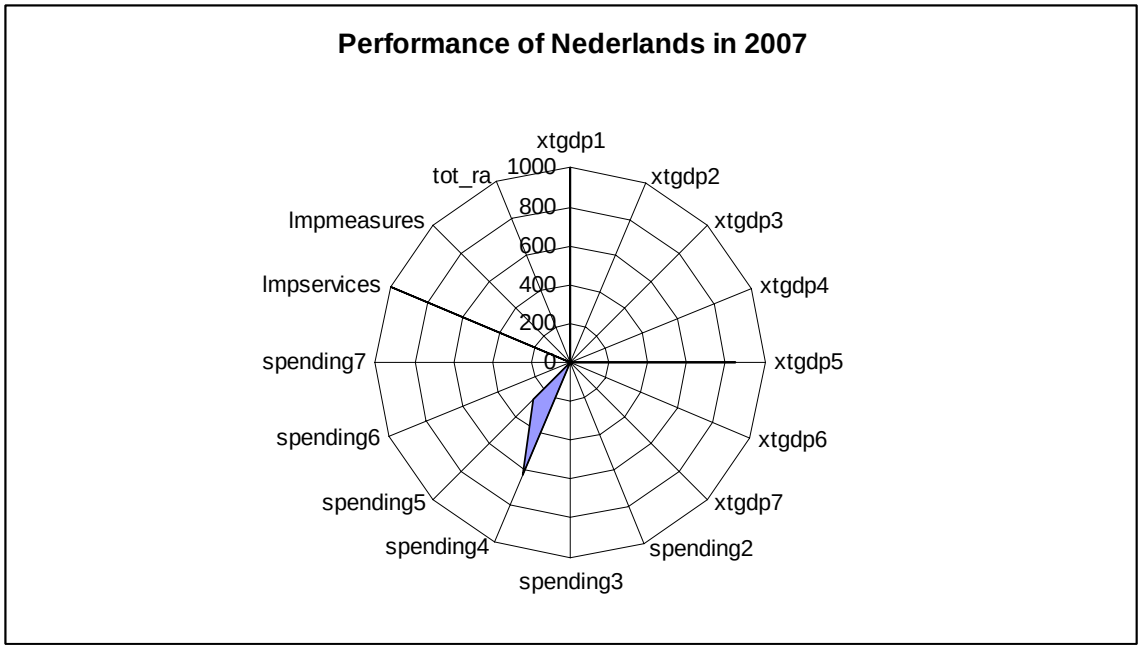
	Rank	Rank	Rank	Rank	Rank	Rank	Rank
HU	14	15	16	17	18	19	20
2004		5.29%	*56.03%*	**37.59%**			
2005			2.38%	*37.67%*	32.55%	**26.36%**	
2006			1.27%	25.13%	*25.77%*	**29.64%**	17.78%
2007	8.07%	7.94%	***38.11%***	39.58%			

In 2006 Hungary confirms the 19th position as in 2005. varying between the 17th to the 20th position where the observations are spread. The median falls in the 18th position, while the mode corresponds with to the position of the AMLP composite indicator. In

2007 Hungary performs its best ranking in the 16th position. On the other hand the median and the mode fall both in the 17th position.

Netherlands

Across the four years the Netherlands performs very well in the overall ranking where the country is ranked from the 2nd to the 4th position. In 2007 as shown in figurexx the best performance of the Netherlands is achieved in the dimension of "*Spending in employment incentives"* where the country is ranked at the 2nd position. On the other hand the country ha no measurement in "*Total regular activation*"



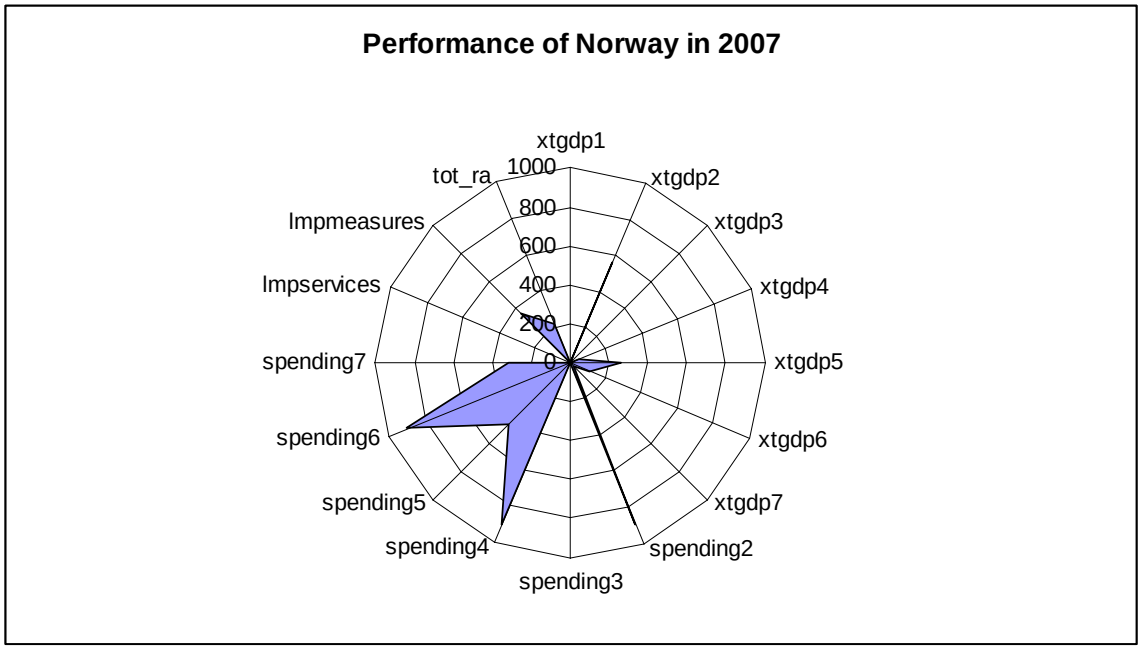
The performance of the Netherlands is not very robust and is one of the countries showing a consistent variability in rankings. In 2004 although the position of the country varies from the 2nd to the 9th position, most of the observations (50%) are recorded from the 3rd and the 4th. The median and the mode of the distribution of the 23800 simulations correspond with the 3rd position while the country ranks the 4th position. In 2005 the Netherlands maintain its 4th position. On the other hand the median and the mode fall both in the 2nd position.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
NL	1	2	3	4	5	6	7	8	9	10
2004		17.63%	18.14%	***14.17%***	12.24%	12.05%		5.96%	7.52%	
2005	21.89%	*36.26%*	16.24%	**13.23%**	5.71%					
2006	27.66%	*32.73%*	**22.78%**	7.14%	4.16%					
2007	6.50%	**19.47%**	7.24%	6.21%	6.50%	*7.46%*	6.30%			19.81%

In 2006 the performance of the country is better ranking in the 3rd position. most of the observations are concentrated between the 2nd and the 3rd position and the median and the mode fall both in the 2nd position. In 2007 the Netherlands performs its best rank in 2nd position. The distribution of the indicator is bimodal because of the presence of missing. The median falls in the 6th position, while the mode corresponds to the 2nd and the 10th position.

Norway

Across the four years Norway is one of the top performers of the Effective Active Labour Market Policies Composite Indicator achieving the 3dr and the 4th position in the ranking. In 2007 this performance is mainly driven by a very good performance in the basic indicators which measure the "*Spending per participant in employment incentives*" and "*Spending per participant in direct job creation"* where the country reaches the 1st position in both the indicators. On the other hands a bad performance is recorded for the indicators of "*LMP expenditure in labour market services*"



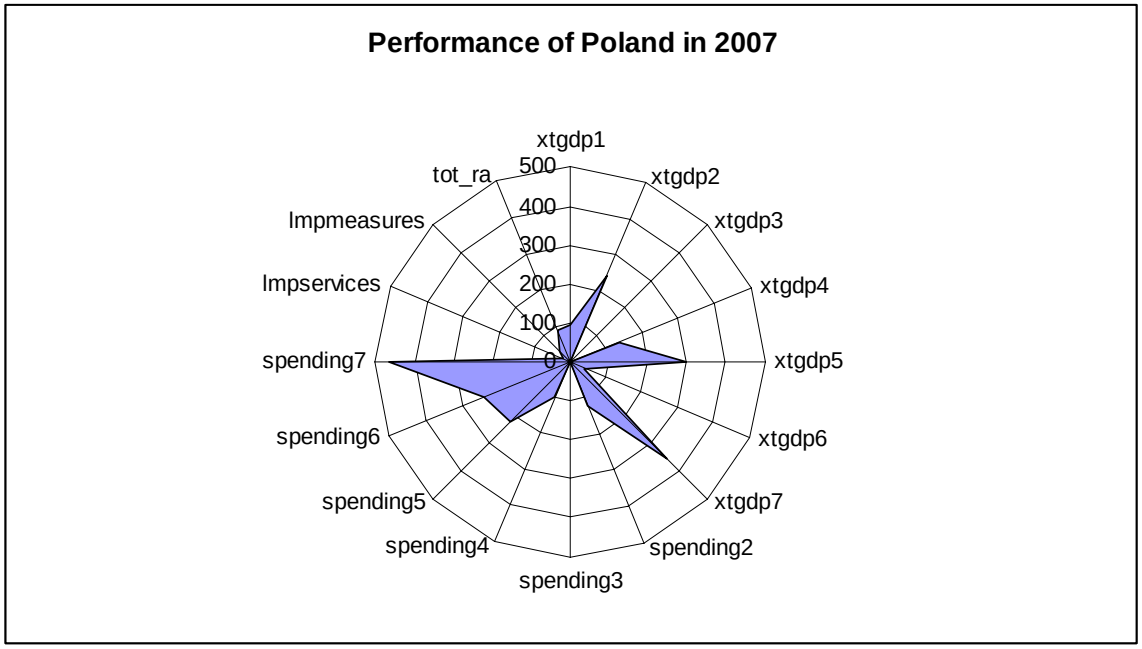
The performance of Norway in the uncertainty analysis is not very robust and is one of the countries showing a consistent variability in ranking. In 2004 Norway ranks the 3rd position varying its position from the 1st to the 6th position where the observations are spread. The mode falls in the 6th position and the median corresponds with to the position of the AMLP composite indicator. In 2005 Norway maintain its 3rd position while the variability of the indicator ranks from the 1st to the 7th position, even if the 45% of the observations are concentrated between the 4th and the 5th position. The median and the mode fall both in the 4th position.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
NO	1	2	3	4	5	6	7	8
2004	15.35%	11.24%	***15.03%***	16.66%	12.71%	21.03%		
2005	5.63%	7.78%	**13.37%**	*31.79%*	15.31%	9.76%	11.91%	
2006				**20.56%**	19.67%	*15.07%*	12.82%	16.13%
2007		8.91%	13.67%	***15.02%***	22.39%	27.54%	9.59%	

In 2006 Norway performs slightly worse respect the 2005 ranking the 4th position. The median falls in the 6th position while the mode corresponds with the position of the AMLP composite indicator. In 2007 the 4th position is still maintains. The mode of the distribution falls in the 6th position while the mode corresponds with the position of the AMLP composite indicator.

Poland

Across the three years the performance of Poland is good enough, the country varies from the 14th to the 15 position in line with the other performances of the Eastern European countries. Poland has been deleted from the 2004 because of its missing data. As shown in the figure below in 2007 the best performance achieved by Poland is recorded for the dimensions of "*Spending per participant in start up incentives*" and "*LMP expenditure in start up incentives* " where the country is ranked at the 1st position in both the indicators. The worst performance of Poland is recorded in the dimension of "*LMP measures and services*".



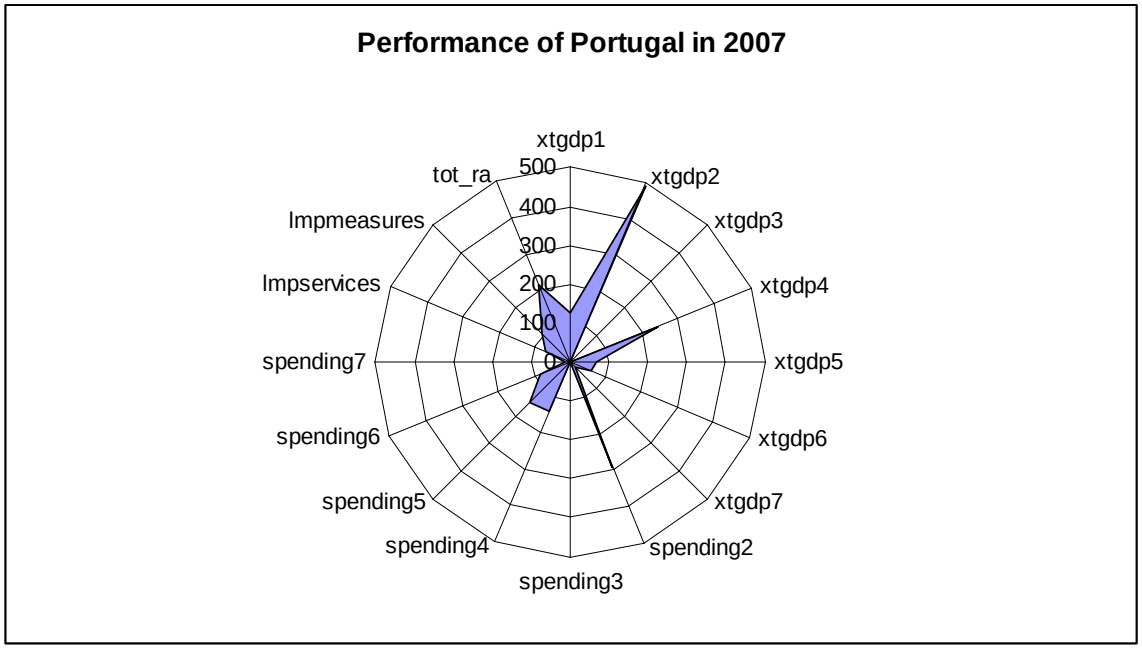
The performance of Poland is robust in the uncertainty analysis. In 2005 the country is ranked in the 15th position in 50% of observations out of 23800 simulations. The median and the mode of the distribution correspond to the 15th position which is the position achieved by the country in the AMLP composite indicator.

	Rank	Rank	Rank	Rank	Rank
PL	12	13	14	15	16
2005		1.17%	10.53%	***50.06%***	37.94%
2006			13.74%	***59.76%***	22.74%
2007	8.42%	*55.26%*	**27.61%**	7.92%	

In 2006 Poland still maintain its 15th position with a frequency of almost 60% of observations. The mode and the median correspond to the position of the AMLP composite indicator. In 2007 Poland performs slightly better respect 2006 and 2005 ranking the 14th position. the median and the mode fall in the 13th position.

Portugal

Across the four years Portugal ranks from the 13th to the 15th position of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. In 2007 Portugal best performance is achieved for the dimensions of "*LMP expenditure in training*", where the country is recorded at the 6th position of the ranking. The Portugal worst performance is indeed recorded for the indicators of "*LMP expenditure in start-up incentives*" where the country is ranked at the 9th position.



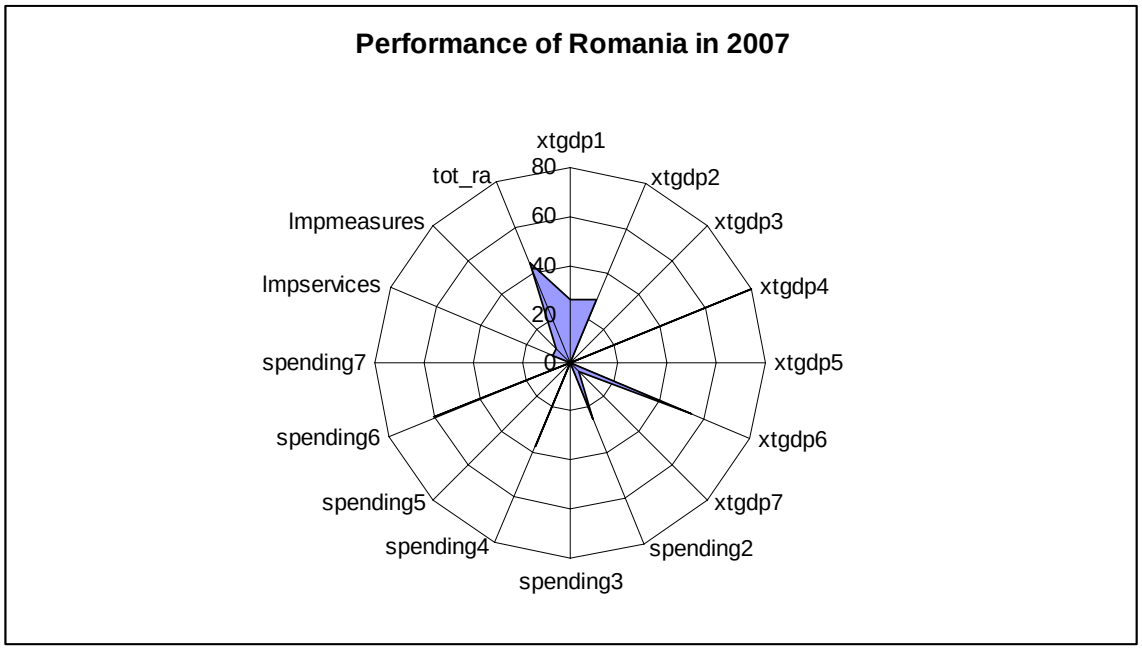
The performance of Portugal is not very robust in the uncertainty analysis. In 2004 the position of the country vary from positions 12th to 15th, even if the 78% of the frequencies are concentrated on positions 14th and 15th. The Portugal ranks the 15th position with 30% of observations among the 23800 performed simulations. The median and the mode of the distribution correspond to the 14th position. In 2005 Portugal performs better its position ranking the 13th position even if with less than 5% of the observations, but this is due to the weights assumption we made in the building of the AMLP composite indicator. The median and the mode are in the 15th position.

	Rank	Rank	Rank	Rank	Rank	Rank
PT	11	12	13	14	15	16
2004		8.45%	12.58%	*48.69%*	**30.22%**	
2005			**1.17%**	10.53%	*50.06%*	37.94%
2006				**13.74%**	*59.76%*	22.74%
2007		8.42%	*55.26%*	27.61%	**7.92%**	

In 2006 Portugal ranks the 14th position while in 2007 the country performs worse ranking the 15th position with less than 10% of the observations.

Romania

Across the four years Romania ranks from the 14th to the 23th position of the overall ranking, in line with the other performances of the Eastern European Country. In 2007 as shows in the figure below the best performance of Romania is recorded for the indicator of "*Total regular activation*". On other hands, Romania worst performance is recorded for the indicators of "*Spending per participant indirect job creation*;" where the country is ranked at the 22nd position.

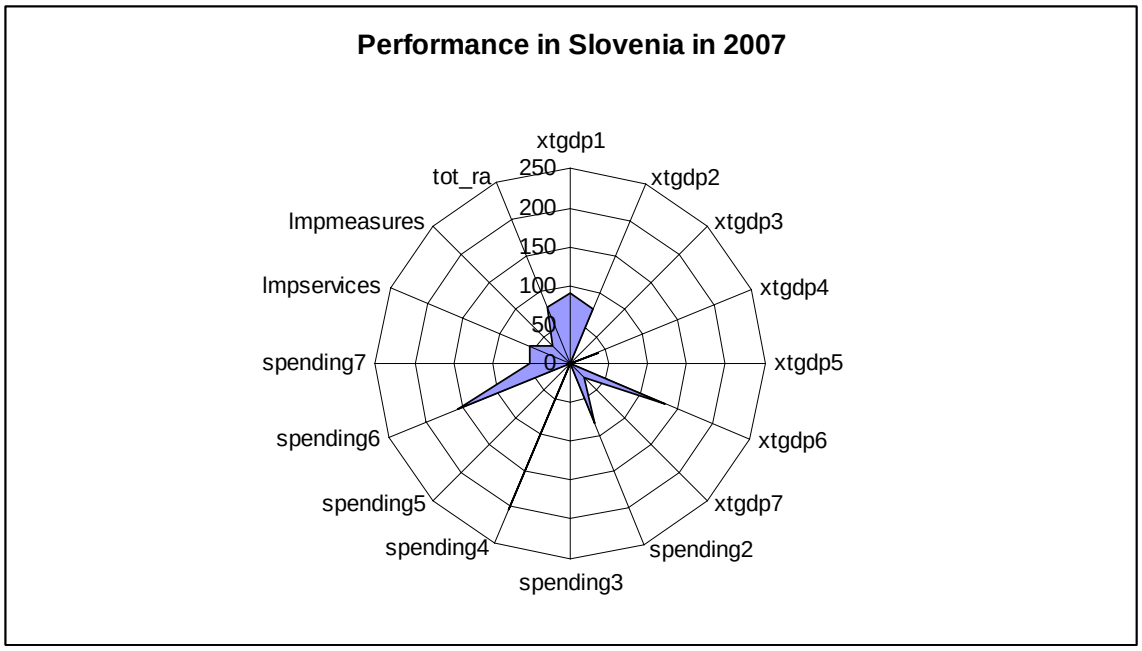


The performance of Romania is not very robust as confirmed in the sensitivity analysis and shows a considerable variability in the ranking positions. In 2004 Romania is ranked in the 14th position in 27% of observations out of 23800 simulations. The median and the mode of the distribution fall in the 15th position. This is the best rank Romania has, in fact in 2005 its performance is worse falling in the 21st position with the 20% of the frequency of the distribution of the observations. The mode and the median are in the 23rd position. In 2006 the performance is even worse ranking the 23rd position with the 70% of the frequency out of 23800 performed simulations. The median and the mode fall in the 23rd position of the distribution which corresponds with the ranking recorded in the AMLP composite indicator. The performance in 2007 is very similar to 2006. Romania ranks the 23rd position with 80% of the frequency. The median and the mode fall in the 23rd position.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
RO	13	14	15	16	17	18	19	20	21	22	23	24
2004	7.78%	***26.95%***	53.68%	4.76%	6.26%							
2005								5.26%	**20.20%**	14.58%	***47.71%***	11.06%
2006									1.74%	25.65%	***70.68%***	0.17%
2007									0.36%	12.82%	***80.31%***	6.51%

Slovenia

Across the three years Slovenia ranks from the 16th to the 17th position of the overall ranking, in line with the other performances of the Eastern European Country. In 2004 Slovenia has not been considered because of its missing values. In 2007 as shows in fugurecc the best performance of Slovenia is recorded for the indicator of "*Spending in direct job creation"*. On other hands, Slovenia worst performance is recorded for the indicators of "*LMP expenditure in employment incentives*;" where the country is ranked at the 24th position.



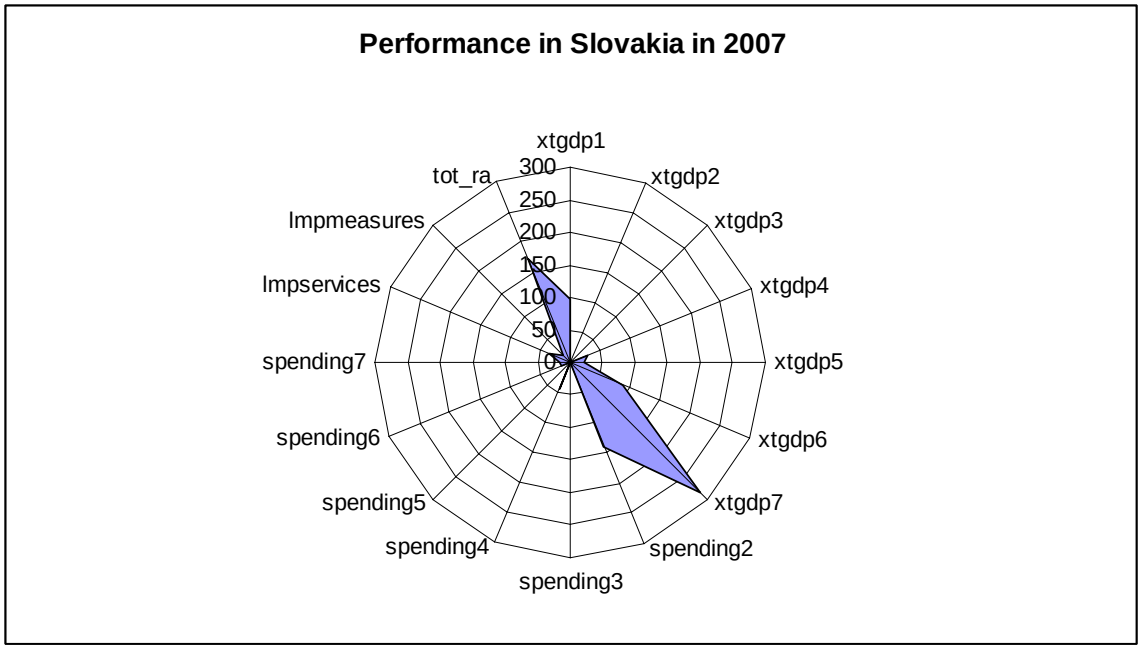
The performance of Slovenia in the uncertainty analysis is not very robust and is one of the countries showing a consistent variability in ranking. In 2005 Slovenia ranks the 16th position. Its performance varies from the 12th to the 16th position even if the frequencies of the simulations are concentrated among position 15th and 16th where focused 70% of the observations out of 23800 performed simulations. The mode of the distribution fall in the 16th which corresponds to the position of the AMLP composite indicator, while the median falls in the 15th , which confirms the high variability of the Slovenia performance.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
SI	12	13	14	15	16	17	18	19
2005	13.17%	6.81%	8.00%	*28.50%*	**41.93%**			
2006		6.82%	5.41%	26.03%	***55.88%***			
2007						**10.23%**	*41.22%*	30.66%

In 2006 the 16th position is maintained with 55% of observations. The median and the mode of the distribution correspond with the position occupied by the country in the AMLP composite indicator. In 2007 the Slovenia performance is worse ranking the 17th position. The median and the mode are in the 18th position confirming again the high variability of Slovenia performance.

Slovakia

Across the four years Slovakia is ranked from the 17th to the 19th position of the overall ranking in line with the other Eastern European Countries. Slovakia shows a considerable good performance for the dimensions of "*LMP expenditure in start up incentives*" where the country is ranked at the 3rd position. Slovakia worst performance is instead achieved for the dimensions of "*Spending per participant in supported employment and rehabilitation"*.



The performance of Slovakia in the uncertainty analysis is robust In 2004 although the uncertainty analysis shows that the ranking position of Slovakia varies from the 17th to

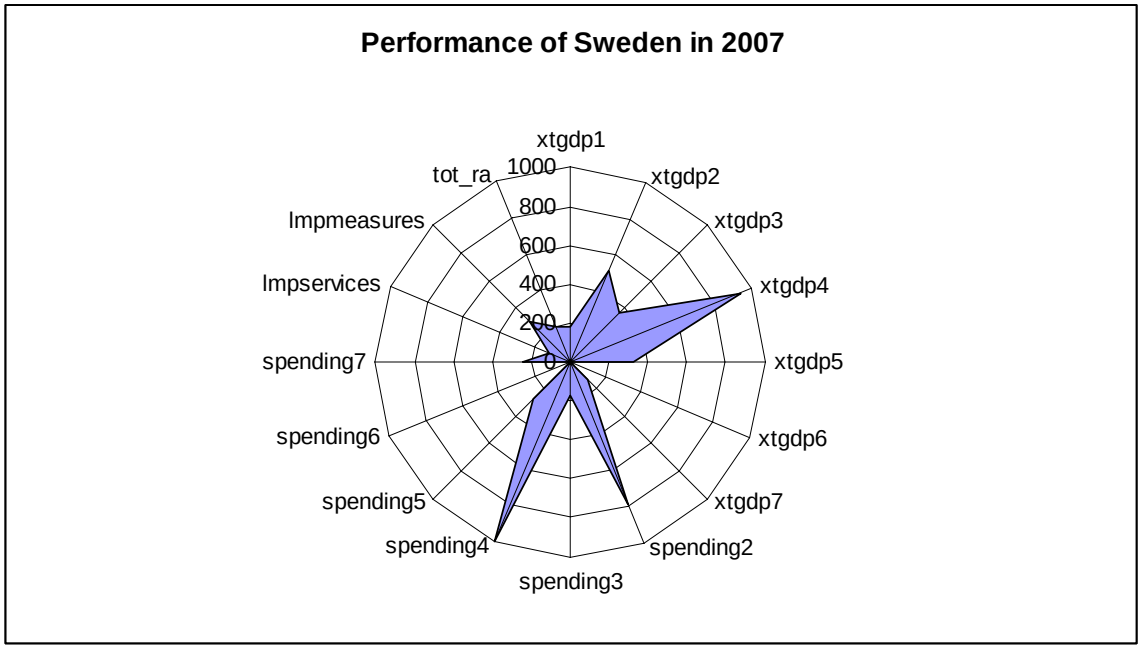
the 22th, the performance of Slovakia can be considered stable because the 53% of the frequencies fall in the 19th position. The median and the mode of the distribution fall in the 19th position which is the position recorded by the country in the AMLP composite indicator. In 2005 the Slovakia performance is better and ranks the 17th position with 51% of frequency of the distribution of observations among 23800 performed simulations. The median and the mode of the distribution fall in the 17th position which is the position recorded by the country in the AMLP composite and confirms the robustness of the indicator.

	Rank	Rank	Rank	Rank	Rank	Rank
SK	17	18	19	20	21	22
2004		2.05%	***53.60%***	21.66%	14.83%	7.86%
2005	***51.76%***	14.25%	23.91%	5.12%		
2006	***49.95%***	9.66%	4.87%	12.29%	18.32%	
2007	6.26%	**16.35%**	19.15%	*41.92%*	13.13%	

In 2006 Slovakia ranks the 17th position as in 2005, while in 2007 its performance is slightly worse falling in the 18th position. The median and the mode are in the 20th position.

Sweden

Across the four years Sweden is the leader of the overall ranking of the Effective Active Labour Market Policies Composite Indicator. In 2007 The Sweden top performance is achieved with a good performance most of the indicators. In particular Sweden achieve the top performance in the *"Spending per participant in employment incentives;"*. The less impressive performance of Sweden is recorded for the dimensions of *"Spending per participant in start up incentives"* where the country achieve the 11th position.



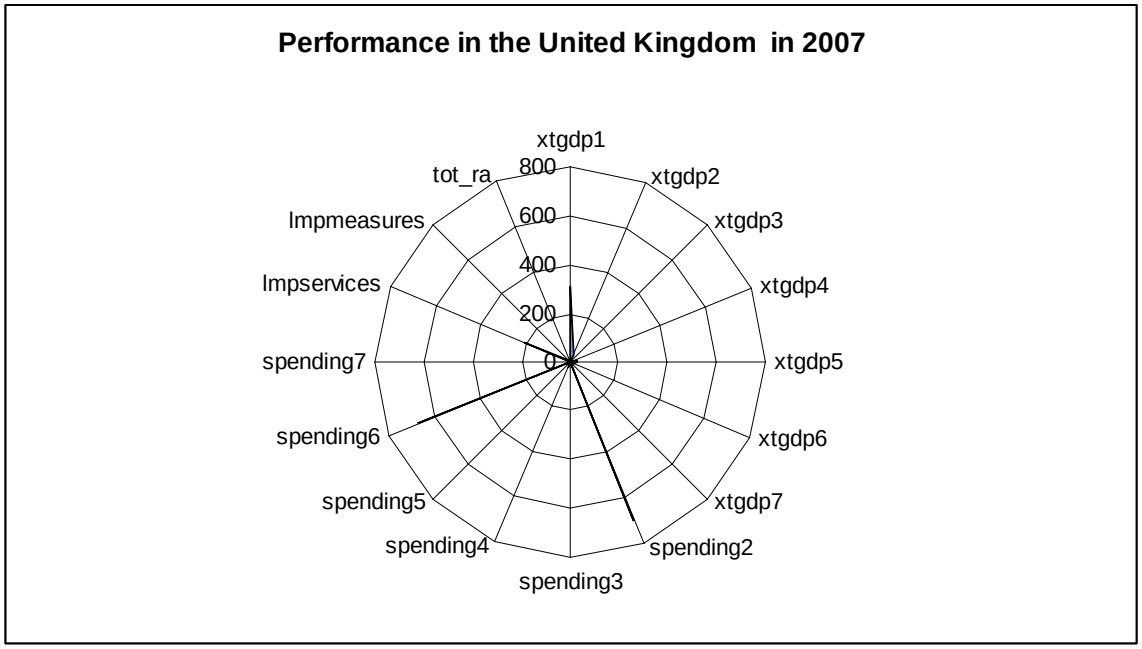
The performance of Sweden is robust as confirmed in the sensitivity analysis. In 2004 Sweden reaches the top of the ranking with a frequency of 28% among the 23800 performed simulations. The median and the mode of the distribution correspond to the 2nd position which is the position achieved by the country in the AMLP composite indicator. In 2005 Sweden maintains the same position. The median and the mode are still in 2nd position which corresponds with the AMLP composite indicator position.

	Rank	Rank	Rank	Rank	Rank
SE	1	2	3	4	5
2004	27.63%	***28.17%***	23.55%	6.95%	
2005	20.18%	***25.24%***	29.39%	9.22%	
2006	26.42%	***27.95%***	27.91%		
2007	11.95%	24.77%	*21.46%*	17.89%	**8.43%**

In 2006 the Sweden performance is still in the 2nd position, although the distribution of the observation presents two modes, the first in 2nd and the second ion the 3rd position. the median is in the 2nd position. In 2007 Sweden performs worse than in the previous years, it ranks in the 5th position. On other hands the mode falls in the 2nd position and the median in the 3rd.

United Kingdom

Across the three years United Kingdom performs always in the middle of the overall ranking between the 13th and the 14th position. In 2007 the performance of the United Kingdom is driven by a poor performance in all the basic indicators. Anyway, the best performance of United Kingdom is achieved for the dimensions of *"LMP expenditure in labour market services"*, where the country achieve the 1st position.



The United Kingdom performance is robust in the uncertainty analysis and the position of the countries varies from position 11th to 15th across the four years. In particular in 2004 rank of United Kingdom varies from the 11th to the 14th position, even if most of the observations are concentrated between in the 13th position. By the way, the median and the mode of the distribution correspond to the 13th position which is the position achieved by the country in the AMLP composite indicator. In 2005 the United Kingdom performance is slightly worse in fact the indicator is in 14th position with 22% of the observations out of 23800 performed simulations. The median falls in the 13th position while the mode corresponds to the position of the AMLP composite indicator.

	Rank	Rank	Rank	Rank	Rank	Rank	Rank
UK	10	11	12	13	14	15	16
2004		26.67%	17.17%	***34.63%***	16.95%		
2005	7.47%	14.84%	18.65%	*19.67%*	**22.22%**		9.79%
2006		18.84%	15.09%	***25.94%***	17.94%	8.33%	7.10%
2007			6.11%	**17.38%**	*18.56%*	34.33%	

In 2006 United Kingdom maintains its rank in 13th position as in 2004. The median and the mode of the distribution fall in the 13th position which is the position recorded by the country in the AMLP composite indicator. In 2007 the variability of the AMLP indicator is concentrated between the 13th and the 15th position. The country ranks in the 13th position, while the median is in the 14th position and the mode in the 15th.

ANNEX 2: UNCERTAINTY AND SENSITIVITY ANALYSIS

Composite indicators may send misleading, non-robust policy messages if they are poorly constructed or misinterpreted. In fact, the construction of composite indicators involves stages where judgment has to be made: the selection of sub-indicators, the choice of a conceptual model, the weighting of indicators, the treatment of missing values etc. All these sources of subjective judgment will affect the message brought by the CIs in a way that deserve analysis and corroboration. A combination of uncertainty and sensitivity analysis can help to gauge the robustness of the composite indicator, to increase its transparency and to help framing a debate around it.

General procedures to assess uncertainty in the AMLP composite indicators building are in this section applied and analyzed. In particular, five main sources of uncertainty can be highlighted and their combined effect on country rankings needs to be tested:

1) Data Normalization
2) Weighting Scheme
3) Composite Indicator Formula (Aggregation Rule)
4) Inclusion/Exclusion of Basic Indicators
5) Imputation of Missing Data via MCMC.

Two combined tools are suggested to assess the uncertainty in the AMLP Composite Indicator: Uncertainty Analysis (UA) and Sensitivity Analysis (SA). UA focuses on how uncertainty in the input factors propagates through the structure of the composite indicator and affects the composite indicator values. SA studies how much each individual source of uncertainty contributes to the output variance.

In the field of building composite indicators, UA is more often adopted than SA (Jamison and Sandbu, 2001; Freudenberg, 2003) and the two types of analysis are almost always treated separately. A synergistic use of UA and SA is proposed and presented here, considerably extending earlier attempts in this direction (Tarantola et al., 2000).

With reference to the uncertainty sources (1 to 5 above), the approach taken to propagate uncertainties could include in theory all of the steps below:

1) Inclusion-Exclusion of basic indicators
2) Using alternative data normalization schemes, such as rescaling, standardization, use of raw data.
3) Using several weighting schemes, i.e. Equal Weights, predetermined set of weights, Principal Components weights, Data envelopment analysis weights.
4) Using several aggregation systems, i.e. linear, another based on geometric mean of un-scaled variable.
5) Testing different set of missing data randomly simulated

General Framework of the Analysis

As described above, we shall frame the analysis as a single Monte Carlo experiment, e.g. by plugging all uncertainty sources simultaneously, as to capture all possible synergistic effects among uncertain input factors. This will involve the use of triggers, e.g. the use of uncertain input factors used to decide e.g. which aggregation system and weighting scheme to adopt. To stay with the example, a discrete uncertain factor which can take integer values between 1 and 3 will be used to decide upon the aggregation system and another also varying in the same range for the weighting scheme. Other trigger factors will be generated to select which indicators to omit, the aggregation rule, the normalization scheme and so on. Below, the sources of uncertainty affecting the AMLP composite indicator are analyzed.

Inclusion – exclusion of individual sub- indicators

No more than one indicator at a time is excluded for simplicity. A single random variable is used to decide if any indicator will be omitted and which one. Note that an indicator can also be practically neglected as a result of the weight assignment procedure. Although this is not the case of the AMLP composite indicator, for instance imagine a very low weight is assigned by an expert to a sub-indicator q . Every time we select that expert in a run of the Monte Carlo simulation, the relative sub-indicator q will be almost neglected for that run.

Normalization

As described in (Nardo et al. 2005) several methods are available to normalise sub-indicators. The methods that are most frequently met in the literature are based on the re-scaled values or on the standardized values or on the raw indicator values. In the robustness assessment of the AMLP composite indicator the Z-score standardization, the Min-Max standardization and the Ranking-based standardization are applied. These three methods are shortly described below.

The Min-Max Standardization

The basic standardization technique that has been applied is the Min-Max approach. Each indicator, q, was standardized based on the following rule:

$$I^{t}_{qc} = \frac{x^{t}_{qc} - \min_{c}(x_{q}^{2004-2007})}{\max_{c}(x_{q}^{2004-2007}) - \min_{c}(x_{q}^{2004-2007})} \cdot 1000 \quad .$$

Using this method, all indicators have been rescaled in such a way as to lie between 0 (laggard $x_{qc}=\min_c(x^{2004\text{-}2007}_q)$) and 1000 (leader, $x_{qc}=\max_c(x^{2004\text{-}2007}_q)$).

Where $\max_c(x^{2004\text{-}2007}_q)$ and $\min_c(x^{2004\text{-}2007}_q)$ are respectively the maximum and the minimum value of the indicator over all countries and years considered.

Standardisation (or Z-scores)

For each sub-indicator $x_{qc}^{2004-2007}$, the average across countries $\bar{x}_{qc}^{2004-2007}$ and the standard deviation across countries $\sigma_{x_{qc}}^{2004-2007}$ are calculated. The normalization formula is:

$$I_{qc}^{2004-2007} = \frac{x_{qc}^{2004-2007} - \bar{x}_{qc}^{2004-2007}}{\sigma_{x_{qc}}^{2004-2007}},$$

So that all the y_{mn} have similar dispersion across countries. This approach converts all indicators to a common scale with an average of zero and standard deviation of one, yet the actual minima and maxima of the standardized values across countries vary among the sub-indicators.

Ranking of indicators across countries

The simplest normalization method consists in ranking each indicator across countries. The main advantages of this approach are its simplicity and the independence to outliers. Disadvantages are the loss of information on absolute levels and the impossibility to draw any conclusion about difference in performance.

$$I_{qc}^{2004-2007} = Rank(x_{qc}^{2004-2007})$$

Weighting Scheme

Central to the construction of a composite index is the need to combine in a meaningful way different dimensions measured on different scales. This implies a decision on which weighting model will be used and which procedure will be applied to aggregate the information.

Addressing the reader to (Nardo et al. 2005) for an exhaustive list of weighting schemes, in the robustness analysis of AMLP composite indicator, three different weighting schemes are adopted and described below.

Equal Weights

In many composite indicators all variables are given the same weight when there are no statistical or empirical grounds for choosing a different scheme. Equal weighting (EW) could imply the recognition of an equal status for all sub-indicators (e.g. when policy assessments are involved).

Alternatively, it could be the result of insufficient knowledge of causal relationships, or ignorance about the correct model to apply (like in the case of Environmental Sustainability Index – World economic forum, 2002), or even

stem from the lack of consensus on alternative solutions (as happened with the Summary Innovation Index - European Commission, 2001a). In any case, EW does not mean any weighting, because EW anyway implies an implicit judgment on the weights being equal. The effect of EW also depends on how component indicators are divided into categories or groups: weighting equally categories regrouping a different number of sub-indicator could disguise different weights applied to each single sub-indicator.

Factor Analysis Weights

Principal component analysis (PCA) and more specifically factor analysis (FA) group together sub-indicators that are collinear to form a composite indicator capable of capturing as much of common information of those sub-indicators as possible. The information must be comparable for this approach to be used: sub-indicators must have the same unit of measurement. Each factor (usually estimated using principal components analysis) reveals the set of indicators having the highest association with it. The idea under PCA/FA is to account for the highest possible variation in the indicators set using the smallest possible number of factors. Therefore, the composite no longer depends upon the dimensionality of the dataset but it is rather based on the "statistical" dimensions of the data. According to PCA/FA, weighting only intervenes to correct for the overlapping information of two or more correlated indicators, and it is not a measure of importance of the associated indicator. If no correlation between indicators is found, then weights can not be obtained estimated with this method. For methodological details we address the reader to (Nardo et al. 2005).

Data Envelopment Analysis, (DEA), Weights

Data envelopment analysis (DEA) employs linear programming tools (popular in Operative Research) to retrieve an efficiency frontier and uses this as benchmark to measure the performance of a given set of countries.17 The set of weighs stems from this comparison. Two main issues are involved in this methodology: the construction of a benchmark (the frontier) and the measurement of the distance between countries in a multi-dimensional framework.

The construction of the benchmark is done by some simple assumptions as: positive weights (the higher the value of one sub-indicator, the better for the corresponding country); non discrimination of countries that are best in any single dimension (i.e. sub indicator) thus ranking them equally; a linear combination of the best performers is feasible (convexity of the frontier). The distance of each country with respect to the benchmark is determined by the location of the country and its position relative to the frontier. The countries supporting the frontier are classified as the best performing, other countries are then ordered according to the distance with respect to the benchmark. For methodological details we address the reader to (Nardo et al. 2005).

The benchmark could also be determined by a hypothetical decision maker (Korhonen et al. 2001, for an indicator of performance of academic research) who is asked to locate the target in the efficiency frontier having the most preferred combination of sub-indicators. In this case the DEA approach could merge with the budget allocation method (see below) since experts are asked to assign weights (i.e. priorities) to sub-indicators.

Aggregation Rules

The literature of composite indicators offers several examples of aggregation techniques. The most used are additive techniques that range from summing up country ranking in each sub indicator to aggregating weighted transformations of the original sub-indicators. However, additive aggregations imply requirements and properties, both of component sub-indicators and of the associated weights, which are often not desirable, at times difficult to meet or burdensome to verify. To overcome these difficulties the literature proposes other and less widespread, aggregation methods like multiplicative (or geometric) aggregations or non linear aggregations like the multi-criteria or the cluster analysis. For the LLL composite indicator we focus our attention on additive methods and geometric aggregation.

Additive methods

The simplest additive aggregation method entails the calculation of the ranking of each country according to each sub-indicator and the summation of resulting ranking (e.g. Information and Communication Technologies Index - Fagerberg J. 2001). By far the most widespread linear aggregation is the summation of weighted and normalized sub-indicators:

$$Y_c^t = \sum_{i=1}^{3} w_i \sum_{j=1}^{k_i} w_j^* I_{ijc}^t$$

Where t is the year of reference, w are the weights of the 3 dimensions, w^* are the weights of basic indicators within each dimension, I the basic indicators and c the country index.

Geometric aggregation

An undesirable feature of additive aggregations is the full compensability they imply: poor performance in some indicators can be compensated by sufficiently high values of other indicators. For example if a hypothetical composite were formed by inequality, environmental degradation, GDP per capita and unemployment, two countries, one with values 21, 1, 1, 1; and the other with 6,6,6,6 would have equal composite if the aggregation is additive. Obviously the two countries would represent very different social conditions that would not be reflected in the composite.

If multicriteria analysis entails full non-compensability, the use of a geometric aggregation (also called deprivational index) is an in-between solution.

$$Y_c^t = \prod_{i=1}^{3} \prod_{j=1}^{k} I_{ijc}^{t\ w_i w_j^*}$$

Where *t* is the year of reference, *w* are the weights of the 3 dimensions, w^* are the weights of basic indicators within each dimension, *I* the basic indicators and *c* the country index.

Uncertainty Analysis

All points showed above chain of composite indicator building can introduce uncertainty in the output variables Rank(I^t_c). Thus we shall translate all these uncertainties into a set of scalar input factors, to be sampled from their distributions. As a result, all outputs Rank(I^t_c) are non-linear functions of the uncertain input factors, and the estimation of the probability distribution functions (pdf) of Rank(I^t_c) is the purpose of the uncertainty analysis. The UA procedure is essentially based on simulations that are carried on the various equations that constitute our model. As the model is in fact a computer programme that implements different scenarios, the uncertainty analysis acts on a computational model. Various methods are available for evaluating output uncertainty.

In the following, the Monte Carlo approach is applied, which is based on performing multiple evaluations of the model with k randomly selected model input factors. The procedure involves different steps and we address the reader to (Nardo et al, 2005, Saltelli et al. 2000a, Saltelli et al. 2000b, Saltelli, A. 2002, Saltelli et al. 2008).

The selected random factors for which the uncertainty is assessed to the AMLP composite indicator are four and are listed below in table 15:

Table 15 - uncertainty factors for the ALMP composite indicator

X_1	Standardization
1	Z-Score
2	Min-Max
3	Ranking across countries

X_2	Weighting Scheme
1	Equal Weight
2	Predetermined set of Weights
3	PCA weights
4	DEA weights

X_3	Aggregation Rule

1	Linear
2	Geometric
3	No further Aggregation (for DEA)

X_4	Excluded Sub-Indicator
1	Indicator 1 omitted
2	Indicator 2 omitted
3	Indicator 3 omitted
...	...
15	Indicator 15 omitted
16	Indicator 16 omitted

X_5	Imputation of Missing Data via MCMC
1	Sample 1 of the set of missing data randomly simulated.
2	Sample 2 of the set of missing data randomly simulated.
3	Sample 3 of the set of missing data randomly simulated.
…	...
100	Sample 100 of the set of missing data randomly simulated..

Where, trigger X_1 is used to select the standardization methods (Z-score, Min-Max, Ranking of Indicators across countries), trigger X_2 is used to select the weighting scheme (Equal weights, Predetermined set of weights, PCA weights, DEA weights).Then trigger X_3 is used to select the aggregation rule (linear/additive, geometric, no further aggregation (just in case of DEA). Trigger X_4 is generated to select which sub-indicator – if any, should be omitted. Finally, trigger X_5 is used to sample 100 set of missing data randomly simulated. Each input factor can be characterized by a probability density function; here we assume uniform distribution for the entire five input factors in order to do not penalize/reward any possible trigger modality.

After having generated the input factors distributions in step 1, we can now generate randomly N combinations of independent input factors X^i, i= l, 2 ,…,N where X^i is a set of outcomes of input factors, called a sample. For each trial sample $X^{l\backslash i}$ the computational model can be evaluated, generating values for the scalar output variable Y_l, where Y_l is the Rank(I^t_c) , the value of the rank assigned by the composite indicator to each country.

In the case of the uncertainty analysis of the AMLP composite indicator the total number of simulations performed is set equal to 23800, which correspond to the total exploration of all the possible combinations of the input factors.

The results of the uncertainty analysis are presented below. For every country the results of the distribution of the scores of the 23800simulations are presented. The results of the simulations are organized in a frequency matrix and the overall AMLP is calculated across the 23800scenarios. Besides the frequency matrix, the median rank per country

was selected in order to compare with the rank recorded in the AMLP composite indicator.

On figures 7-10 the frequency distribution in all four years for all countries rank is presented. These frequencies are estimated over the 23800 different scenarios. On table 17 an example of frequency distribution of a country rank over the 23800 scenarios is presented. A color code is used to distinguish different frequencies as illustrated in table 16:

Table 16 - Colour Codes

	Frequency lower than 10%
	Frequency between 10% and 20%
	Frequency between 20% and 35%
	Frequency between 35% and 50%
	Frequency higher than 50%
bold	Position in the ALMP composite indicator
Italic	median
Red	mode of the distribution

Moreover, **Bold**, *Italic* and Red represent the country rank in the ALMP composite indicator, the median and the mode of the 23800 simulations, respectively. For example Austria in 2004 has a distribution encoded as follows in table 17:

Table 17 – Frequencies of Austria performance in the 23800 scenarios in 2004.

Rank	4	5	6	7	8	9	10
AUSTRIA	1.36%	3.97%	14.74%	25.14%	***17.96%***	8.59%	28.24%

This means that the country is ranked in positions 4th to 10th among the 23800 simulations performed. In particular, Austria is ranked in position 4th, 5th and 9th with a frequency lower than 10%, in position 6th and 8th with a frequency between 15% and 30% and in position 7th and 10th with a frequency between 25% and 35%. Position 10th is the mode, whereas the median falls in position 8th which is also the position of the country in the composite indicator.

In the following tables, the frequency matrices for the period 2004-2007 are presented. Due to the huge number of simulation performed, just frequencies higher than 5% are shown. Most countries show a moderate degree of variability in their ranking, mainly as a result of imputation of missing data. The extent of such variability varies to some extent across countries.

Figure 7 - Results of the Uncertainty Analysis, ranking distribution per country for 2004

2004		LU	SE	NO	NL	DE	BE	FI	AT	IE	FR	IT	ES	UK	RO	PT	BG	HU	CZ	SK	LT	EE	LV
Rank	1	40.01%	27.63%	15.35%		10.35%																	
Rank	2	16.83%	28.17%	11.24%	17.63%	19.69%	5.87%																
Rank	3	10.94%	23.55%	15.03%	18.14%	13.94%	14.08%																
Rank	4	10.12%	6.95%	16.66%	14.17%	12.85%	28.92%																
Rank	5	6.82%		12.71%	12.24%	29.81%	17.85%	7.26%															
Rank	6			21.03%	12.05%	10.05%	18.34%	8.85%	14.74%														
Rank	7						7.64%	16.98%	25.14%	20.67%	12.26%												
Rank	8							23.29%	17.96%	23.67%	19.77%												
Rank	9							24.67%	8.59%	32.75%	20.86%												
Rank	10							11.63%	28.24%	17.35%	31.05%												
Rank	11											23.09%	49.26%	26.67%									
Rank	12											48.43%	25.95%	17.17%									
Rank	13											23.45%	21.55%	34.63%	7.78%	12.58%							
Rank	14													16.95%	26.95%	48.69%							
Rank	15														53.68%	30.22%			6.18%				
Rank	16																23.09%	56.03%	15.99%				
Rank	17																17.30%	37.59%	38.84%				
Rank	18																56.86%		38.76%				
Rank	19																			53.60%	35.43%	8.43%	
Rank	20																			21.66%	35.53%	24.91%	17.24%
Rank	21																			14.83%	27.31%	23.82%	34.04%
Rank	22																			7.86%		42.30%	48.38%

Figure 8 - Results of the Uncertainty Analysis, ranking distribution per country for 2005

2005		LU	SE	NO	NL	FI	BE	IE	DE	AT	FR	IT	ES	PT	UK	PL	SI	SK	BG	HU	CZ	RO	LT	LV	EE
Rank	1	34.88%	20.18%	5.63%	21.89%																				
Rank	2	18.39%	25.24%	7.78%	36.26%																				
Rank	3	18.48%	29.39%	13.37%	16.24%	8.54%	4.03%		9.42%																
Rank	4	7.42%	9.22%	31.79%	13.23%	14.45%	14.12%		6.38%																
Rank	5	5.38%		15.31%	5.71%	29.02%	19.22%		13.07%																
Rank	6			9.76%		13.68%	18.82%	10.28%	28.29%	11.07%															
Rank	7			11.91%		15.97%	14.42%	17.71%	19.92%	13.27%															
Rank	8					5.07%	7.02%	27.45%	12.86%	35.58%															
Rank	9						5.31%	31.55%	8.41%	31.71%	8.95%														
Rank	10										69.36%		5.18%		7.47%										
Rank	11										15.47%	17.01%	5.42%	45.57%	14.84%										
Rank	12											26.05%	13.25%	23.59%	18.65%		13.17%								
Rank	13											31.95%	21.22%	16.94%	19.67%		6.81%								
Rank	14											12.05%	40.95%	6.25%	22.22%	10.53%	8.00%								
Rank	15											7.01%	9.52%		4.82%	50.06%	28.50%								
Rank	16														9.79%	37.94%	41.93%								
Rank	17																	51.76%		37.67%					
Rank	18																	14.25%	27.25%	32.55%	25.45%				
Rank	19																	23.91%	16.71%	26.36%	25.34%		5.36%		
Rank	20																	5.12%	35.13%		39.06%	5.26%	10.73%		
Rank	21																		10.75%		5.08%	20.20%	45.72%	13.52%	
Rank	22																		7.97%			14.58%	25.60%	44.79%	6.51%
Rank	23																					47.71%	8.72%	24.72%	18.44%
Rank	24																					11.06%		12.25%	72.76%

Figure 9 - Results of the Uncertainty Analysis, ranking distribution per country for 2006

2005		LU	SE	NO	NL	FI	BE	IE	DE	AT	FR	IT	ES	PT	UK	PL	SI	SK	BG	HU	CZ	RO	LT	LV	EE
Rank	1	34.88%	20.18%	5.63%	21.89%																				
Rank	2	*18.39%*	***25.24%***	7.78%	*36.26%*																				
Rank	3	18.48%	29.39%	**13.37%**	16.24%	8.54%	4.03%		9.42%																
Rank	4	7.42%	9.22%	*31.79%*	**13.23%**	14.45%	14.12%		6.38%																
Rank	5	5.38%		15.31%	5.71%	***29.02%***	*19.22%*		13.07%																
Rank	6			9.76%		13.68%	**18.82%**	10.28%	*28.29%*	11.07%															
Rank	7			11.91%		15.97%	14.42%	**17.71%**	19.92%	13.27%															
Rank	8					5.07%	7.02%	*27.45%*	**12.86%**	*35.58%*															
Rank	9						5.31%	*31.55%*	8.41%	**31.71%**	8.95%														
Rank	10										***69.36%***		5.18%		7.47%										
Rank	11										15.47%	**17.01%**	5.42%	*45.57%*	14.84%										
Rank	12											*26.05%*	**13.25%**	23.59%	18.65%		13.17%								
Rank	13											*31.95%*	*21.22%*	**16.94%**	*19.67%*		6.81%								
Rank	14											12.05%	*40.95%*	6.25%	***22.22%***	10.53%	8.00%								
Rank	15											7.01%	9.52%		4.82%	***50.06%***	*28.50%*								
Rank	16														9.79%	37.94%	***41.93%***								
Rank	17																	***51.76%***		*37.67%*					
Rank	18																	14.25%	**27.25%**	*32.55%*	25.45%				
Rank	19																	23.91%	*16.71%*	**26.36%**	*25.34%*		5.36%		
Rank	20																	5.12%	*35.13%*		***39.06%***	5.26%	10.73%		
Rank	21																		10.75%		5.08%	**20.20%**	*45.72%*	13.52%	
Rank	22																		7.97%			14.58%	**25.60%**	*44.79%*	6.51%
Rank	23																					*47.71%*	8.72%	**24.72%**	18.44%
Rank	24																					11.06%		12.25%	***72.76%***

Figure 10 - Results of the Uncertainty Analysis, ranking distribution per country for 2007

2007		LU	NL	BE	NO	SE	FI	IE	DE	AT	FR	ES	IT	UK	PL	PT	HU	SI	SK	LT	CZ	BG	LV	RO	EE
Rank	1	***43.06%***	6.50%	27.20%		11.95%	9.70%																		
Rank	2	*13.05%*	**19.47%**	13.58%	8.91%	*24.77%*	9.53%				8.39%														
Rank	3	8.22%	7.24%	***19.84%***	13.67%	*21.46%*	18.10%		6.26%																
Rank	4	6.31%	6.21%	*20.63%*	**15.02%**	17.89%	*21.96%*				6.11%														
Rank	5	5.82%	6.50%	10.08%	*22.39%*	**8.43%**	*24.55%*		11.74%	5.70%	4.56%														
Rank	6	6.40%	*7.46%*	7.39%	*27.54%*		**12.74%**		*21.26%*	5.46%	5.29%														
Rank	7	6.26%	6.30%		9.59%			**21.07%**	*26.61%*	17.17%	5.83%														
Rank	8							*31.45%*	**14.34%**	*26.82%*	*9.48%*														
Rank	9							28.71%	10.29%	***29.54%***	15.66%														
Rank	10		19.81%					14.32%		11.95%	***38.76%***	8.41%													
Rank	11		6.46%									***47.36%***	28.45%			11.48%									
Rank	12											28.76%	***34.64%***	6.11%	8.42%	17.51%									
Rank	13											7.42%	8.69%	**17.38%**	*55.26%*	*10.10%*									
Rank	14												11.23%	*18.56%*	**27.61%**	28.20%	8.07%								
Rank	15													*34.33%*	7.92%	**31.20%**	7.94%			7.24%	5.65%				
Rank	16																***38.11%***			*37.20%*	12.70%				
Rank	17																*39.58%*	**10.23%**	6.26%	26.87%	8.15%				
Rank	18																4.26%	*41.22%*	**16.35%**	11.94%	*16.81%*				
Rank	19																	30.66%	19.15%	**6.70%**	*25.87%*	7.80%			
Rank	20																	9.82%	*41.92%*	7.99%	**14.68%**	*16.89%*			
Rank	21																		13.13%		13.52%	*48.67%*	19.68%		
Rank	22																					22.98%	*63.42%*	12.82%	
Rank	23																						10.84%	*80.31%*	8.00%
Rank	24																							6.51%	***91.89%***

The overall variation in the position is synthesized for each year (figures 11-14). The width of the 5%-95% percentile bounds across the 23800 simulations represent the different rankings achieved by each country. Black marks correspond to the median AMLP composite indicator rank and whiskers show best and worst rank occupied by a country considering the 23800 simulations. The confidence bound proved the stability and robustness of the ranking. In fact for instance in 2004 over the 23800 simulations 2 are the countries which shift less than 3 positions while about 12 countries present only 1 shift position in the ranking. In 2005 only 5 countries (approximately the 20% of the total number of countries) shift of 2 positions, in 2006 less than 10% of countries present a variability of 3 positions, while in 2007 just one country, The Netherlands, present a variability of 8 positions.

In the relevant literature, the median rank is proposed as a summary measure of a rank distribution. The median rank of all combinations of assumptions indicates that for instance in 2006 for 13 out of 24 countries the AMLP rank corresponds with the most likely (median) rank. Thus, for the remaining countries the difference between the AMLP rank and the most likely (median) rank is less than 3 positions. So that, for all the countries studied in all the four years, the very modest sensitivity of the AMLP ranking to the five input factors (standardization, weighting scheme, aggregation rule, inclusion/exclusion of a single indicator and missing imputation) implies a considerably high degree of robustness of the index for all the countries. The comparison in all four years is shown from table 18 to table 21.

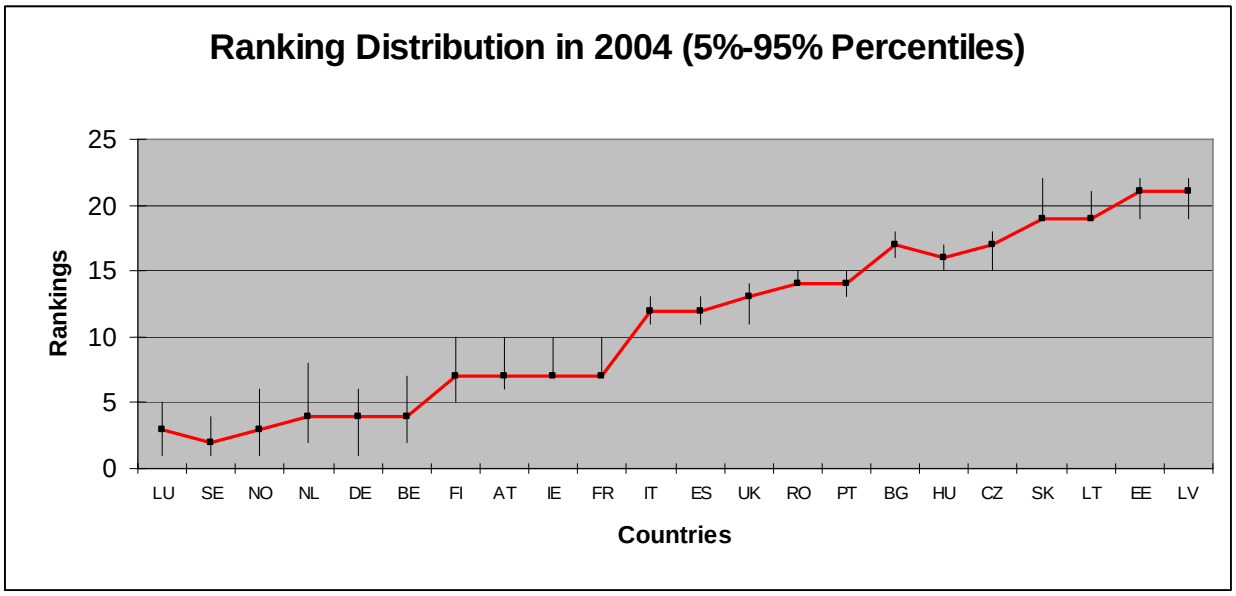


Figure 11: Results of the Uncertainty Analysis: Ranking Position in 2004 (5%-95% percentiles)

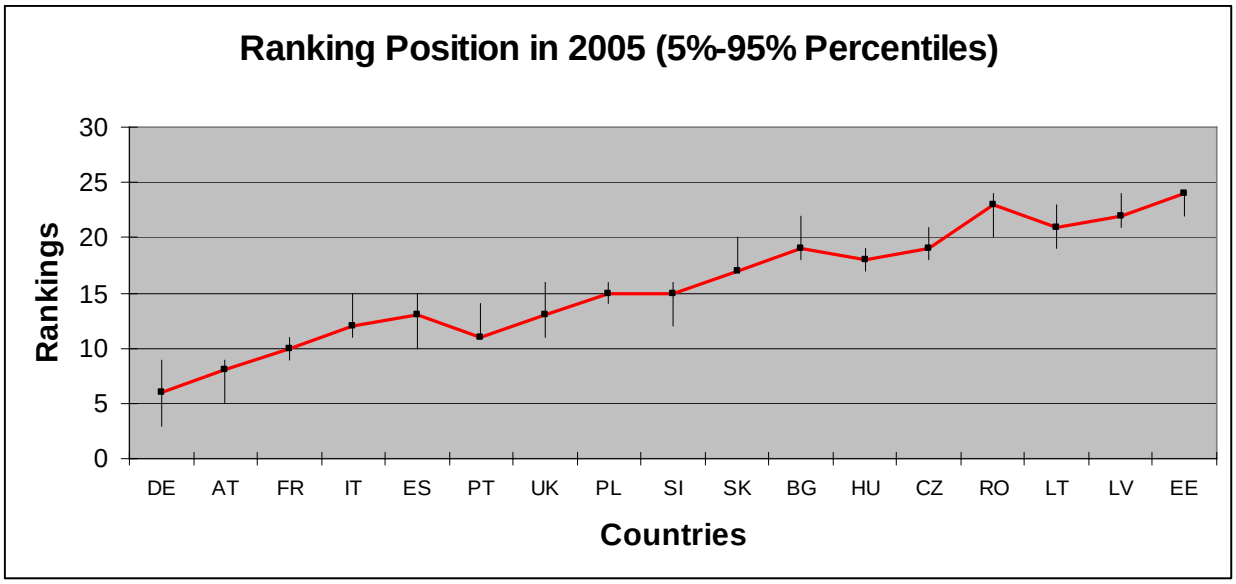


Figure12: Results of the Uncertainty Analysis: Ranking Position in 2005 (5%-95% percentiles)

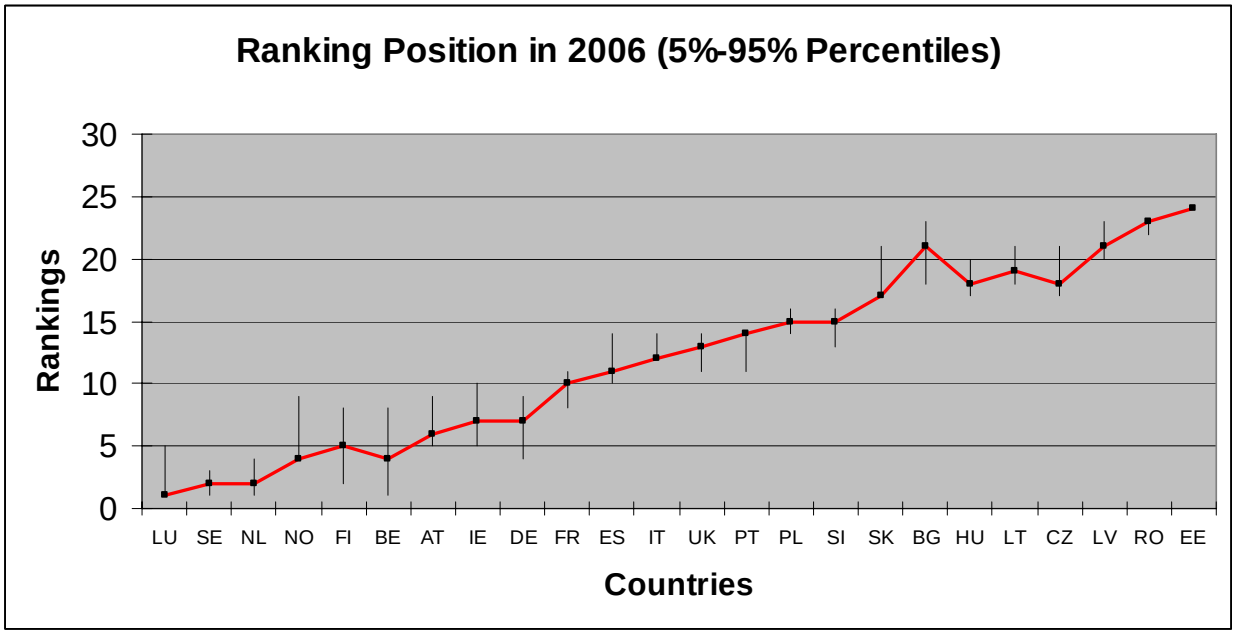


Figure 13: Results of the Uncertainty Analysis: Ranking Position in 2006 (5%-95% percentiles)

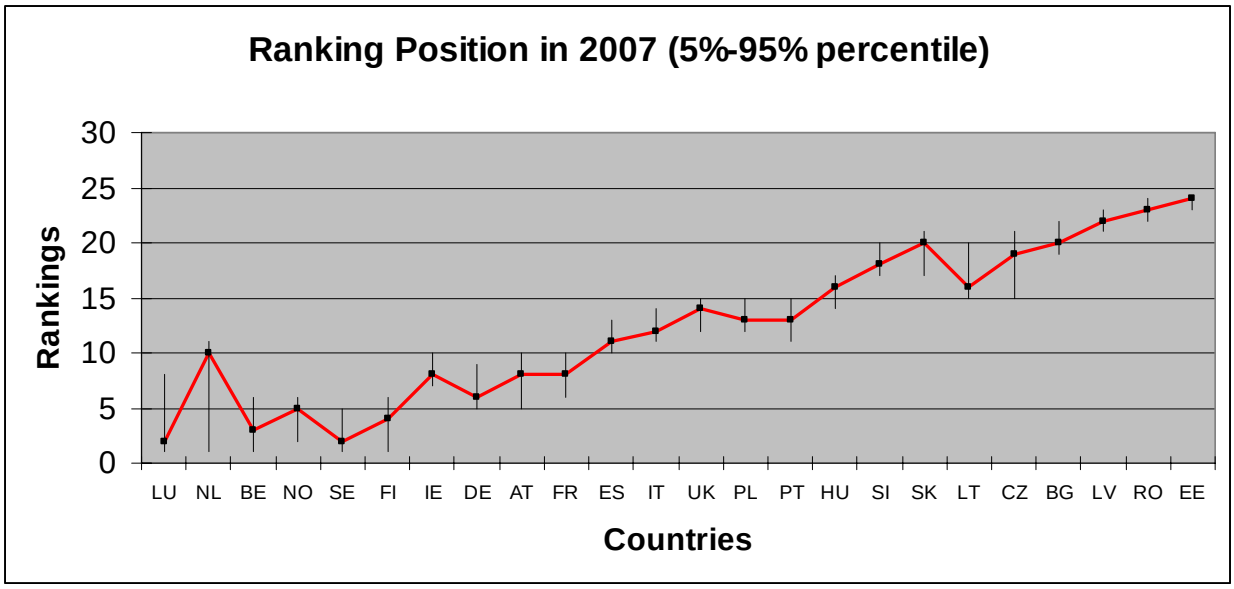


Figure 14: Results of the Uncertainty Analysis: Ranking Position in 2007 (5%-95% percentiles)

Table 18: Comparison of median values and AMLP composite indicator ranking in 2004

2004	LU	SE	NO	NL	DE	BE	FI	AT	IE	FR	IT	ES	UK	RO	PT	BG	HU	CZ	SK	LT	EE	LV
median	3	2	3	4	4	4	7	7	7	7	12	12	13	14	14	17	16	17	19	19	21	21
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Table 19 Comparison of median values and AMLP composite indicator ranking in 2005

2005	LU	SE	NO	NL	FI	BE	IE	DE	AT	FR	IT	ES	PT	UK	PL	SI	SK	BG	HU	CZ	RO	LT	LV	EE
median	2	2	4	2	5	5	9	6	8	10	12	13	11	13	15	15	17	19	18	19	23	21	22	24
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Table 20 Comparison of median values and AMLP composite indicator ranking in 2006

2006	LU	SE	NL	NO	FI	BE	AT	IE	DE	FR	ES	IT	UK	PT	PL	SI	SK	BG	HU	LT	CZ	LV	RO	EE
median	1	2	2	4	5	4	6	7	7	10	11	12	13	14	15	15	17	21	18	19	18	21	23	24
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Table 21 Comparison of median values and AMLP composite indicator ranking in 2007

2007	LU	NL	BE	NO	SE	FI	IE	DE	AT	FR	ES	IT	UK	PL	PT	HU	SI	SK	LT	CZ	BG	LV	RO	EE
median	2	10	3	5	2	4	8	6	8	8	11	12	14	13	13	16	18	20	16	19	20	22	23	24
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

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Abstract

This paper presents a composite indicator to measure Effective Active Labour Market Policies (ALMP) using 16 indicators based on the Eurostat's Labour Market Policies DataBase. Alongside the composite index on Life Long Learning (LLL) previously elaborated, the present index has been developed within the joint DG EMPL/DG JRC project aimed to measure Flexicurity in the EU[2] through a set of four composite indicators corresponding to the four main pillars of flexicurity as identified in the 2006 Commission Communication on this topic (COM(2007) 359). The ALMPs index is computed following the methodology developed in the OECD/JRC handbook on composite indicators. The paper is organized as follows. Section 2 lists the indicators and presents their characteristics and problems. Section 3 presents the methodology adopted for computation of a composite indicator. Section 4 shows the results. Section 5 carries out uncertainty analysis of their robustness. Finally, section 6 presents results on a country-by-country basis.

[2] This publication has been produced through a systematic collaboration between the Joint Research Centre (Institute for the Protection and Security of the Citizen) and the Directorate General of Employment, Social Affairs and Equal Opportunities (Unit D1, Employment Analysis, with Matteo Governatori acting as the main liaison person), within the joint research project "Statistical analysis in support of Flexicurity policy" (DG EMPL-JRC Administrative Arrangements 30566-2007-03).

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