Measuring Environmental Performance of the Regions of Czech Republic by Sustainable Value Approach

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Abstract: The purpose of this paper is to demonstrate how efficiently the regions of the Czech Republic used their environmental resources. The quest for sustainability has led to the development of various tools and techniques to measure the progress of on-going efforts. These tools and techniques used for the measurement of sustainability are still evolving. Sustainable Value approach is another simple tool for measuring sustainability performance which integrates the three dimensions of sustainability: the economic development, environmental sustainability and social development. The sustainable value approach assesses how efficiently organizational entities (in this study: regions) use their resources. This paper uses the principles of the sustainable value approach to estimate how the regions of the Czech Republic utilised their environmental resources.

Key-Words: Environmental Sustainability, Regional Sustainability, Regions of the Czech Republic, Sustainable Development, Sustainable Value

1 Introduction:

In the past, it was assumed that environmental sustainability and economic development were at odds. Often, it was thought that environmental progress generated costs which came at the expense of wealth generation, industrial expansion, and jobs creation. The environment was viewed as an endless source of raw materials, energy and a place to dispose of industrial wastes. But today, environmental sustainability is increasingly being seen as a key element of economic development.

Countries around the world including the Czech Republic are finding new strategies to link economic development to the environment protection. Cities and regions are forging new innovative strategies for integrating environmental assets into their economic development agendas by targeting environmental technology firms, supporting efforts to implement advanced pollution prevention technology in industry, positioning business to tap into rapidly growing green markets, and improving their quality of life through investments in their environmental amenities or natural capital. Many regions across the world, have sought to unify their economic development, social, and environmental agendas in what is referred to as sustainable development.

To both help motivate and monitor their on-going efforts it is important to measure the environmental performance and regions are increasingly looking for new methods measures and develop indicators and benchmarking systems usually referred to as environmental indicators to measure their environmental goals.

Environmental and Sustainability measurements are the quantitative basis for the informed management of sustainability. The quest for achieving sustainability has led to the development of various tools and measures for structuring and conducting sustainable development policy analyses and the metrics used for the measurement of sustainability are still evolving. They include indicators, benchmarks, audits, indexes and accounting, as well as assessment, appraisal [4] and other reporting systems which are applied over a wide range of spatial and temporal scales. [9][1] Most of these tools and measures emphasize the importance of frameworks that synchronize the principles and dimensions of sustainable development.

Evaluating the environmental sustainability performance of a nation is complex task and selecting meaningful and effective tools, or metrics, for measuring the environmental consequences and activities is becoming increasingly important. The simplicity and generic qualities of environmental indices currently necessitates a much broader analysis in order to evaluate any nations genuine environmental sustainability credentials-ultimately

the development of a synthetic Environmental Sustainability Index is required to fulfil this task. [14]

2 Methodology

2.1 Study Area and Source of Data

Purpose of this paper is to analyse environmental performance of the14 regions of the Czech Republic. All data were collected from the Czech Statistical Office (regional and national GDP, acreage of arable land, electricity consumption) and Czech Hydrometeorological Institute (data about the REZZO 1-4 emissions), so the resources follow the same definition and measurement rules through the paper.

2.2 The Sustainable Value approach

Sustainable Value (SV) approach is another simple tool for measuring sustainability performance. The concept was developed by Prof Frank Figge of Queen's University Belfast and Dr Tobias Hahn of (IZT) Institute for Futures Studies and Technology Assessment in Berlin. [7][8][17] The whole performance of any entity depends not only financial resources but also environmental and social resources and Sustainable Value integrates these three dimensions of sustainability: the economic development, environmental sustainability and social development. The sustainability framework is primarily used to assess corporate sustainability performance in monetary terms. Value is generally created by an entity if the profitability exceeds the costs incurred shown by the formula below which generally is the measure of the economic performance.

Value = Profitability – Costs. (1)

SV approach extends the above basic rule of calculation to find the value created with environmental and social resources by expressing the charges related to environmental and social impacts in monetary terms. The logic of the SV approach is to *determine the value created by the use of such or such environmental or social resource (or the emission of such or such environmental resource and compare the profitability of alternative uses of these resources (Opportunity Costs) when the same resources are used otherwise how additional value can be created?* [17]

A value is created only if the profitability exceeds the opportunity costs. Opportunity costs or economic opportunity cost is the value of the next best alternative foregone as a result of making a decision. The notion of opportunity costs plays a crucial part in ensuring that scarce resources are used efficiently. The SV approach compares the use of resources by an entity to the use of resources by a benchmark and defines the cost of the resource by its opportunity cost. It expresses subsequently the sustainable performance in monetary terms. [17] In this paper, the SV approach is used to assess environmental performance of the regions of the Czech Republic by using traditional concept of SV calculation and focusing only on the value created based on selected environmental indicators in the regions.

2.3 Calculation of Environmental Sustainable Value

The calculation SV is generally by five steps. [9] Each step is defined by a question. As will be shown below, we will follow these steps to calculate environmental sustainable value of the regions of Czech Republic.

Step 1: How many resources does the region use?

The initial step is to determine the quantity of resources used the entity during the time period, usually a one year period. The concept usually adopts the Triple-Bottom-Line indicators (economic, social and environmental) however in this paper since we are only concern with environmental performance we only considered environmental indicators for the environmental resources the regions used to create value in the second step. The chosen indicators for this paper are those of the environmental resources used by the regions of the Czech Republic to demonstrate their environmental performance. These selected Environmental indicators are given in Table 1 below

Table 1 Chosen Environmental indicators

Arable Land (ha)
Electricity (MWh)
Particulate matter-emissions (t)
SO_2-emissions (t)
NO_x-emissions (t)
CO-emissions (t)
VOC-emissions (t)
NH_3-emissions (t)
Waste generated by enterprises (t)

Source: Authors

Step 2: How much return does the region create with its resources?

The second step is to establish the return the regions created with the environmental resources determined in the previous step. In this paper the return considered is the regional income and output of a given region's economy measured by the Gross Domestic Product (GDP). The GDP is the value of goods and services produced within a country's borders in a given year. The following are key in the second step:

- Gross Domestic Product (GDP) is defined as a return for each region and year.
- To calculate regional resource efficiency, each indicator in a concrete year is divided by appropriate GDP.

The results show how much each region creates per unit of each resource.

For example, in 2006 the Pardubice region emitted 18 487, 1 tons of CO and had a GDP of 5 031 569 376 Euros therefore the CO efficiency of the Pardubice region in 2006 is calculated as:

$$\frac{GDP}{Resource} = \frac{5\ 031\ 569\ 376\ €}{18\ 487\ t} = 272\ 168\ €/t \quad (2)$$

Step 3: How much return would the benchmark have created with these resources?

This step focuses in establishing the return the benchmark (in this paper Czech Republic) would create by using the environmental resources of the country. It is assumed that each environmental resource can only be used once so it is not possible to benefit from both returns (the return a region creates and the return the benchmark would create). The resource efficiencies of the benchmark are calculated by dividing the GDP of Czech Republic by the total amount of each environmental resource used during the year. The efficiency of the benchmark shows how much value is created by the benchmark per unit of environmental resource. Benchmark environmental efficiency is analogically calculated (Table 2).

Table 2 Benchmark Efficiencies (2006 - 2012)

	2006	2007	2008	2009	2010	2011	2012
Arable Land (EUR/ha)	40 115	45 372	33 671	47 081	50 288	49 392	51 109
Electricity (EUR/MWh)	2 732	3 044	3 070	3 178	3 334	3 215	3 322
Particulate matter (EUR/t)	1 929 523	2 060 621	2 202 267	2 319 756	2 411 288	2 601 462	2 551 378
SO_2 (EUR/t)	578 354	635 372	807 292	813 260	888 142	870 804	991 281
NO_x (EUR/t)	435 293	485 844	539 756	563 624	635 469	657 737	723 515
CO (EUR/t)	253 356	271 202	321 335	339 102	379 828	388 032	279 979
VOC (EUR/t)	681 933	791 202	863 709	891 186	1 000 659	1 063 579	1 075 089
NH_3 (EUR/t)	1 921 956	2 296 175	2 498 964	2 078 553	2 198 707	2 253 875	2 383 911
Waste by enterprises (EUR/t)	5 734	6 355	6 425	6 924	7 407	7 440	7 673

Aource: Authors

These benchmark efficiencies are then used to calculate the Opportunity Costs (OC). OC are the returns that the benchmark would have created with the resources of the region. Continuing with our example, in order to determine the Opportunity Costs of Pardubice region's CO emissions in 2006, we calculated how much return the benchmark (Czech Republic) would have generated with the region's (Pardubice) emissions by multiplying the Pardubice's 18 487 tons of CO with the CO-efficiency of the Czech Republic 253 356 EUR/t as:

*OC of CO in 2006 = 253 356 * 18 487 = 4 683 792 372 EUR* (3)

It is necessary to know benchmark efficiency and amount of each resource used in the region to calculate OC.

Step 4: Which resources are used by the region in a value-creating way?

Here the return the regions created is compared to the return the benchmark would have created with the environmental resources (Opportunity Cost). The return that the regions create corresponds to its Gross Domestic Product (GDP). The opportunity costs of each resource are subtracted from the Gross Domestic Product of the region. In other words, Value Contribution (VC) of each environmental resource is calculated. VC shows how much more or less a region creates with a resource compared to the benchmark. The Table 3 below show the calculation of value contributions in 2006 of the Pardubice region based on the environmental indicators used and a GDP of 5 031 569 376 Euros.

Table 3 Calculation of Value Contribution for Pardubice Region in 2006

Environmental Indicators	GDP (EUR)	Opportunity Costs (EUR)	Value Contribution (EUR)
Arable Land (in hectar)	5 031 569 376	8 020 392 525	- 2 988 823 149
Electricity (in MWh)	5 031 569 376	5 533 116 868	- 501 547 492
Particulate matter (t)	5 031 569 376	6 521 787 740	- 1 490 218 364
SO_2 (t)	5 031 569 376	8 109 679 788	- 3 078 110 412
NOx (t)	5 031 569 376	8 047 696 984	- 3 016 127 608
CO (t)	5 031 569 376	4 683 792 372	347 777 004
VOC (t)	5 031 569 376	5 900 084 316	- 868 514 940
NH_3 (t)	5 031 569 376	9 277 281 612	- 4 245 712 236
Waste by enterprises (t)	5 031 569 376	2 511 492 000	2 520 077 376

Source: Authors

As can be seen in the table 3 above, Pardubice region used only 2 out of the selected environmental resources in a value-creating way as compared to the benchmark (Czech Republic).

Step 5: How much Sustainable Value does the region create?

To obtain SV of environmental performance, it is necessary to sum all the VC of all environmental resources (calculated in step 4 above) for each year and divide the sum by the number of environmental resources considered. It reflects how much more (positive SV) or less (negative SV) return has been created due to the fact that resources were given to the region rather than to the benchmark. In case of positive SV, the region used its environmental resources in a value creating way. In case of negative SV, the region used its resources less efficiently compared to the benchmark. The table below shows the calculation of SV for the environmental resources used in 2006 for the Pardubice region.

Table 4 Calculation of the SV of the Pardubice Region in 2006

Environmental Indicators	GDP (EUR)	Opportunity Costs (EUR)	Value Contribution (EUR)
Arable Land (in hectar)	5 031 569 376	8 020 392 525	- 2 988 823 149
Electricity (in MWh)	5 031 569 376	5 533 116 868	- 501 547 492
Particulate matter (t)	5 031 569 376	6 521 787 740	- 1 490 218 364
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CO (t)	5 031 569 376	4 683 792 372	347 777 004

VOC (t)	5 031 569 376	5 900 084 316	- 868 514 940
NH_3 (t)	5 031 569 376	9 277 281 612	- 4 245 712 236
Waste by enterprises (t)	5 031 569 376	2 511 492 000	2 520 077 376
Sustainable Value			**-1 480 133 313**

Source: Authors

That means the region with its return of more than 5 031 million Euros did not cover the total opportunity costs of its environmental resources. In order words the Pardubice R. did not used its environmental resources in a value creating way compared to the Czech Republic on average.

3 Results

This paper analysed the environmental sustainability of the fourteen regions of the Czech Republic for a period of seven years (2006 – 2012). In Table 5 below, Environmental Sustainable Value development from 2006 to 2012 in every region of the Czech Republic is presented. Prague as the capital city is considered to be a special region for this study. Due to its special position (thanks to the high concentration of business activities) it generates twice more return than the second region in order. On the other hand, enterprises in Prague generate significantly greatest amount of waste from all the regions.

Table 5 Environmental Sustainable Value of the regions of the Czech (in mil. EUR)

Region\Year	2006	2007	2008	2009	2010	2011	2012
Prague	22 139	22 042	26 423	25 939	27 386	26 490	28 248
Central Boh. R.	-3 621	-3 238	- 3 554	- 4 582	- 4 954	- 4 833	- 5 491
South Boh. R.	- 1 660	- 1 796	- 2 857	- 3 053	- 3 177	- 2 911	- 3 541
The Plzen R.	- 1 788	- 1 663	- 2 388	- 2 287	- 2 008	- 1 532	- 1 914
The Kar. Vary R.	-1 306	-1 669	-1 486	-1 157	-1 456	-1 222	-1 410
The Usti R.	-7 955	-8 288	-8 399	-9 849	-9 973	-10 456	-10 262
The Liberec R.	1 222	1 098	378	923	1 004	777	875
The Hr. Kr. R.	-141	2	-51	20	-104	-12	-287
The Pardubice R.	-1 480	-1 687	-1 767	-1 830	-2 331	-2 102	-2 916
The Vysocina R.	-3 060	-2 453	-2 917	-3 310	-3 659	-3 188	-3 681
The S. Mor. R.	1 925	1 978	2 714	1 929	3 439	3 684	4 167
The Olomouc R.	-552	- 111	-90	-371	-252	-391	-594
The Zlin R.	921	1 025	1 501	1 421	1 238	1 264	1 594
The Mor.-Sil. R.	-4 644	-5 342	-4 390	-3 998	-5 173	-5 424	-3 883

Source: Authors

The Sustainable Value gives an absolute figure which shows how much more (positive SV) or less (negative SV) return a region generates with a given set of environmental resources in comparison to a benchmark (Czech Republic) and as an absolute monetary figure Sustainable Value depends on the size of region. To take the size of the region into consideration, a Sustainable Value Margin (SVM) was calculated as shown in table below. The indicator which is chosen to represent the size of each region is GDP. SVM is calculated by dividing Sustainable Value by Regional GDP of the region. This tackles the problem of size by relating the sustainable value of the region to another indicator representing the size of the region.

Table 6 Calculation of SVM of the Pardubice Region in 2006

	GDP (EUR)	Sustainable Value (EUR)
	5 031 569 376	-1 480 133 313
SVM	**- 0,29**	

Source: Authors

Table 6 Sustainable Value Margin in the regions of the Czech Republic

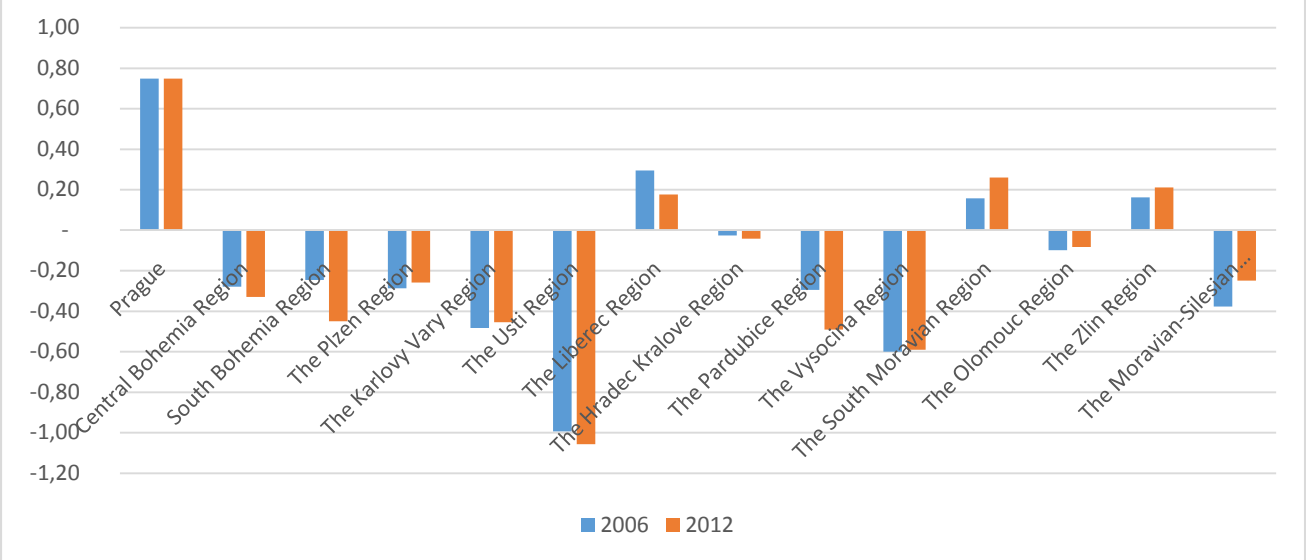
Region\Year	2006	2007	2008	2009	2010	2011	2012
Prague	0,75	0,65	0,73	0,72	0,71	0,72	0,75
Central Boh. R.	-0,28	-0,22	-0,23	-0,30	-0,31	-0,30	-0,33
South Boh. R.	-0,25	-0,25	-0,39	-0,41	-0,41	-0,39	-0,45
The Plzen R.	-0,29	-0,24	-0,36	-0,34	-0,28	-0,21	-0,26
The Kar. Vary R.	-0,48	-0,55	-0,49	-0,37	-0,46	-0,40	-0,45
The Usti R.	-0,99	-0,94	-0,92	-1,04	-1,02	-1,12	-1,06
The Liberec R.	0,29	0,25	0,08	0,21	0,21	0,16	0,18
The Hr. Kr. R.	-0,03	0,0004	-0,01	0,0030	-0,01	-0,0017	-0,04
The Pardubice R.	-0,29	-0,30	-0,31	-0,32	-0,39	-0,35	-0,49
The Vysocina R.	-0,60	-0,43	-0,52	-0,58	-0,61	-0,53	-0,59
The S. Mor. R.	0,16	0,14	0,18	0,13	0,22	0,24	0,26
The Olomouc R.	-0,10	-0,02	-0,01	-0,06	-0,04	-0,06	-0,08
The Zlin R.	0,16	0,16	0,22	0,21	0,17	0,18	0,21
The Mor.-Sil. R.	-0,38	-0,38	-0,30	-0,29	-0,34	-0,36	-0,25

Source: Authors

The results reveal environmental sustainability performance of each region with the size of the region on mind. For better illustration, the same data for 2006 and 2012 are shown in a graph. We can observe not only the performance position of each region, but also progress over time. There was environmental sustainability performance improvement in seven regions, performance declined over time in six regions. Prague, as the smallest region but the best environmental sustainability performance region stagnates.

From more detailed calculations it is obvious, that Prague in all included environmental aspects creates positive value, except the indicator Waste generated by enterprises.

Figure 1 Sustainable Value Margin trends



Source: Authors

From the final Sustainable Value Margin ranking we can easily identify particular position of each region in interregional comparison.

The results are more or less constant. None of the regions significantly improved its position in interregional comparison from 2006.

Table 7 Sustainable Value Margin ranking

Region\Year	2006	2007	2008	2009	2010	2011	2012
Prague	1	1	1	1	1	1	1
Central Boh. R.	8	7	7	8	8	8	9
South Boh. R.	7	9	11	12	11	11	10
The Plzen R.	9	8	10	10	7	7	8
The Kar. Vary R.	12	12	12	11	12	12	11
The Usti R.	13	13	13	13	13	13	13
The Liberec R.	2	2	4	2	3	4	4
The Hr. Kr. R.	5	5	5	5	5	5	5
The Pardubice R.	10	10	9	9	10	9	12
The Vysocina R.	14	14	14	14	14	14	14
The S. Mor. R.	4	4	3	4	2	2	2
The Olomouc R.	6	6	6	6	6	6	6
The Zlin R.	3	3	2	3	4	3	3
The Mor.-Sil. R.	11	11	8	7	9	10	7

Source: Authors

4 Discussion and Conclusion

To measure environmental performance, we used Sustainable Value approach in this paper. Sustainable Value uses Triple-bottom-line (economic, environmental and social indicators) to assess sustainable performance. Generally this methodology is used to measure corporate sustainable performance. However, contribution of this paper lies in application of the framework of SV to measure regional environmental performance where we focused on the environmental aspects using the environmental indicators to see if the regions created value. In our paper SV approach aims to assess how efficiently fourteen regions of the Czech Republic use their environmental resources compared to the benchmark (Czech Republic on average).

One of the final evaluations express which regions created positive value (used its environmental resources in a value creating way). These value creating regions are Prague, the South Moravian R., the Zlin R. and the Liberec R. Analysis also shows SV development in all regions over years 2006 to 2012.

We can assume that the wider selection of environmental indicators is included in the analysis, the more faithful result we get.

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