

CONSIDERATIONS REGARDING THE EVOLUTION OF GROSS DOMESTIC EXPENDITURE ON R&D (GERD) IN ROMANIA AND EU COUNTRIES. PART II – DYNAMIC RHYTHMS

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In this paper we have analyzed the evolution of Gross Domestic Expenditure on R&D (GERD) in Romania and EU countries on the last ten years with the available data (2013-2022) provided by the EUROSTAT database. The time series indicators that we used are the dynamic rhythms.

Key words: GERD, time series, indicators, dynamic rhythms

1. INTRODUCTION

All sectors of activity have a Gross domestic expenditure on R&D (GERD) at national and regional level. We have analyzed the data from business enterprise sector (BES); government sector (GOV); higher education sector (HES); and private non-profit sector (PNP).

2. METHOD

The time series indicators that we used in our analysis are the dynamic

indices with fixed base
(1)

$$i_{t/1\%} = \frac{y_t}{y_1} \cdot 100$$

and the dynamic indices with

chain base
(2)

$$i_{t/t-1\%} = \frac{y_t}{y_{t-1}} \cdot 100$$

We also calculated the changing rates of dynamic rhythms with

fixed base
(3)

$$r_{t/1\%} = (i_{t/1} - 1) \cdot 100$$

and the changing rates of dynamic rhythms with chain base.
(4)

$$r_{t/t-1\%} = (i_{t/t-1} - 1) \cdot 100$$

The data are from the years 2013 to 2022.

3. RESULTS AND DISCUSSION

3.1. All sectors of performance

With the data available of GERD in all sectors we calculated the

rhythms with chain base in EU Countries and then we extracted the minimum and the maximum values for each of the 27 countries. You can see those results in Table 1 to Table 4.

Table 1 Rhythms with chain base – minimum and maximum values in all sectors (a)

Country	AT	BE	BG	CY	CZ	DE	DK
MIN	-1.947	3.377	-13.661	-4.731	-8.829	-3.129	-1.308
R	2020/2019	2020/2019	2016/2015	2015/2014	2016/2015	2020/2019	2017/2016
MAX	49.542	106.110	142.607	142.943	81.081	52.309	43.143
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

Table 2 Rhythms with chain base – minimum and maximum values in all sectors (b)

Country	EE	EL	ES	FI	FR	HR	HU
MIN	-17.085	1.574	-1.468	-11.340	-1.321	-4.180	-9.217
R	2016/2013	2014/2013	2014/2013	2016/2013	2020/2019	2014/2013	2016/2015
MAX	96.825	110.472	48.517	18.731	21.225	170.490	78.864
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2021/2013

Table 3 Rhythms with chain base – minimum and maximum values in all sectors (c)

Country	IE	IT	LT	LU	LV	MT	NL
MIN	-2.760	-4.689	-15.926	-4.163	-27.464	-17.889	1.459
R	2018/2017	2020/2019	2016/2015	2020/2019	2016/2015	2016/2015	2015/2014
MAX	73.247	25.147	107.770	24.988	109.374	101.150	54.568
R	2022/2013	2019/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

Table 4 Rhythms with chain base – minimum and maximum values in all sectors (d)

Country	PL	PT	RO	SE	SI	SK
MIN	-4.730	-1.161	-3.874	-5.513	-14.194	-30.890
R	2016/2015	2014/2013	2020/2019	2014/2013	2017/2013	2016/2015
MAX	177.607	82.607	133.756	32.907	28.560	75.976
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

Analyzing the minimum values among the rhythms (R) with chain base we have the minimum value in Slovakia ($R_{2016/2015} = -30.89\%$ meaning that the value of GERD decreased with 30.89% from 2015 to 2016) and the maximum value in

Belgium ($R_{2020/2019} = 3.377\%$ meaning that the value of GERD increased with 3.377% from 2019 to 2020).

Analyzing the maximum values among the rhythms (R) with chain base we have the minimum value in

Finland ($R_{2022/2013} = 18.731\%$ meaning that the value of GERD increased with 18.731% from 2013 to 2022) and the maximum value in Poland ($R_{2022/2013} = 177.607\%$ meaning that the value of GERD increased with 177.607% from 2013 to 2022).

In Romania we have the minimum value $R_{2020/2019} = -3.874\%$ meaning that the value of GERD decreased with 3.874% from 2019 to 2020 and the maximum value $R_{2022/2013} = 133.756\%$ meaning that the value of GERD increased with 133.756% from 2013 to 2022.

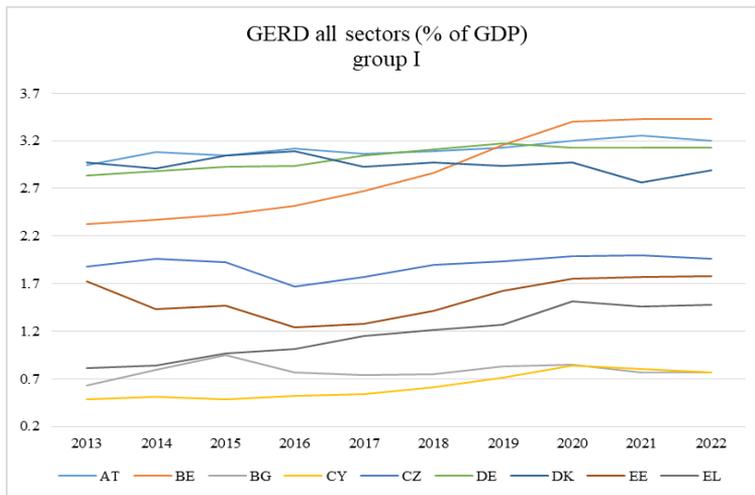


Fig. 1 The evolution of GERD in all sectors (AT – EL)

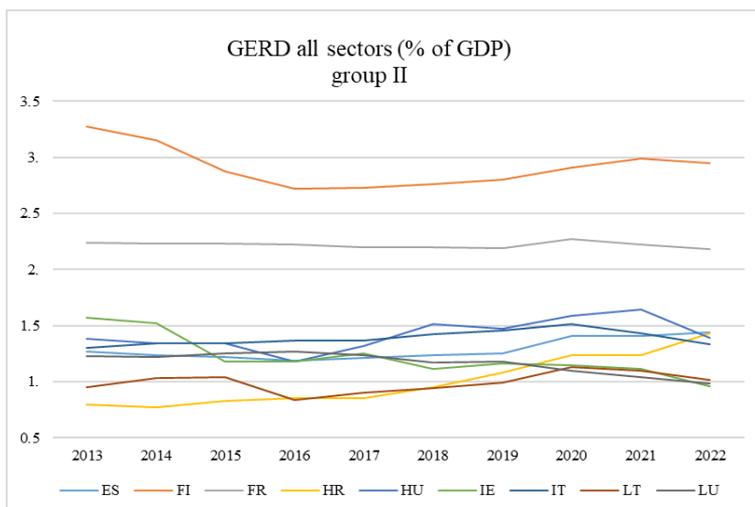


Fig. 2 The evolution of GERD in all sectors (ES – LU)

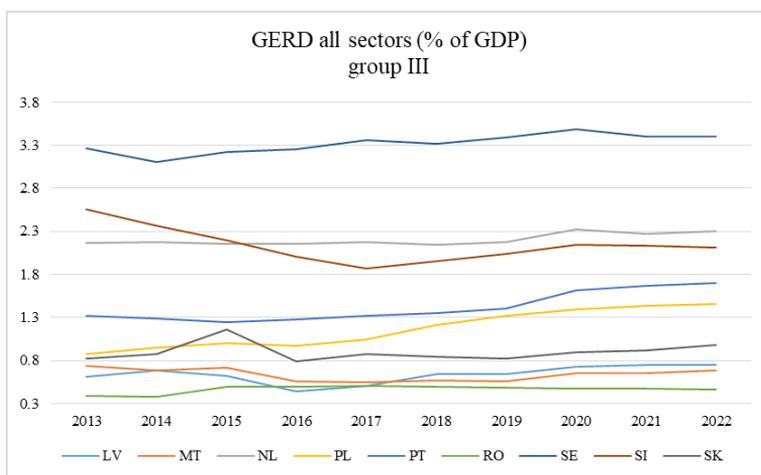


Fig. 3 The evolution of GERD in all sectors (LV – SK)

As you can see in Figure 1 to Figure 3 above, the GERD in all sectors (% of GDP) has the highest values in Sweden – GERD € [3.1%-3.49%], Belgium – GERD € [2.33%-3.43%], and Austria – GERD € [2.95%-3.26%].

The lowest values of GERD in all sectors are in: Latvia – GERD € [0.44%-0.75%], Malta – GERD € [0.55%-0.69%], and Romania – GERD € [0.39%-0.51%].

3.2. Business enterprise sector

For the GERD in business enterprise sector we calculated the rhythms with chain base in EU Countries and then we extracted the minimum and the maximum values. The results are in Table 5 to Table 8.

Table 5 Rhythms with chain base – minimum and maximum values in business enterprise sector (a)

Country	AT	BE	BG	CY	CZ	DE	DK
MIN	-3.037	3.538	-13.777	-2.659	-2.538	-6.328	-3.831
R	2020/2019	2020/2019	2016/2015	2015/2014	2020/2019	2020/2019	2017/2016
MAX	45.414	118.436	169.374	411.825	118.063	52.726	38.995
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

Table 6 Rhythms with chain base – minimum and maximum values in business enterprise sector (b)

Country	EE	EL	ES	FI	FR	HR	HU
MIN	-19.776	2.706	-1.768	-15.225	-1.691	-7.722	-11.521
R	2014/2013	2019/2018	2014/2013	2016/2013	2020/2019	2014/2013	2022/2021
MAX	131.830	209.882	57.850	17.263	23.512	192.957	94.385
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2021/2013

Table 7 Rhythms with chain base – minimum and maximum values in business enterprise sector (c)

Country	IE	IT	LT	LU	LV	MT	NL
MIN	0.210	-6.764	-8.249	-11.966	-34.948	-0.988	0.752
R	2022/2021	2020/2019	2015/2014	2020/2019	2015/2014	2016/2015	2015/2014
MAX	92.252	44.500	295.678	26.455	166.827	158.067	60.994
R	2022/2013	2019/2013	2022/2013	2019/2013	2022/2013	2022/2013	2022/2013

Table 8 Rhythms with chain base – minimum and maximum values in business enterprise sector (d)

Country	PL	PT	RO	SE	SI	SK
MIN	3.478	-3.443	-1.873	-8.125	-16.150	-12.714
R	2020/2019	2014/2013	2020/2019	2014/2013	2017/2013	2014/2013
MAX	319.378	139.199	374.066	42.003	18.297	117.632
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

Analyzing the minimum values among the rhythms (R) with chain base we have the minimum value in Latvia ($R_{2015/2014} = -34.948\%$ meaning that the value of GERD decreased with 34.948% from 2014 to 2015) and the maximum value in Belgium ($R_{2020/2019} = 3.538\%$ meaning that the value of GERD increased with 3.538% from 2019 to 2020).

Analyzing the maximum values among the rhythms (R) with chain base we have the minimum value in Finland ($R_{2022/2013} = 17.263\%$

meaning that the value of GERD increased with 17.263% from 2015 to 2016) and the maximum value in Cyprus ($R_{2022/2013} = 411.825\%$ meaning that the value of GERD increased with 411.825% from 2013 to 2022).

In Romania we have the minimum value $R_{2020/2019} = -1.873\%$ meaning that the value of GERD decreased with 1.873% from 2019 to 2020 and the maximum value $R_{2022/2013} = 374.066\%$ meaning that the value of GERD increased with 374.066% from 2013 to 2022.

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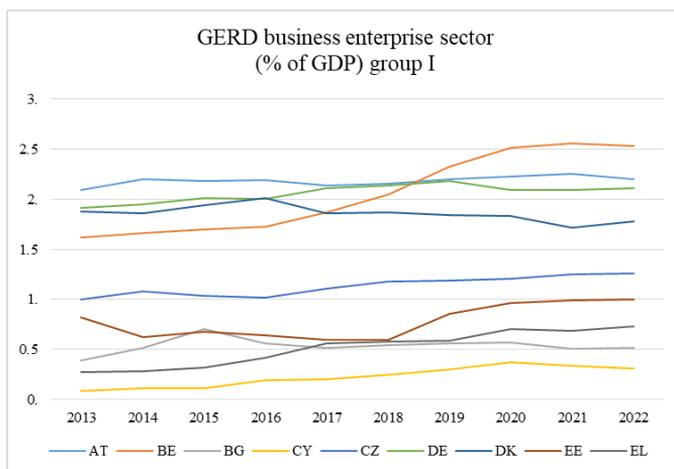


Fig. 4 The evolution of GERD in business enterprise sector (AT – EL)

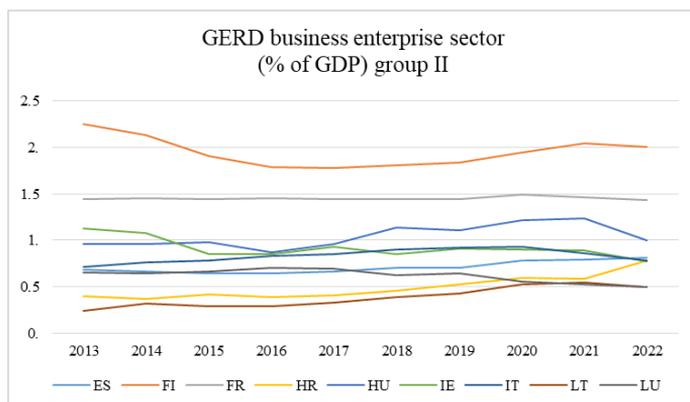


Fig. 5 The evolution of GERD in business enterprise sector (ES – LU)

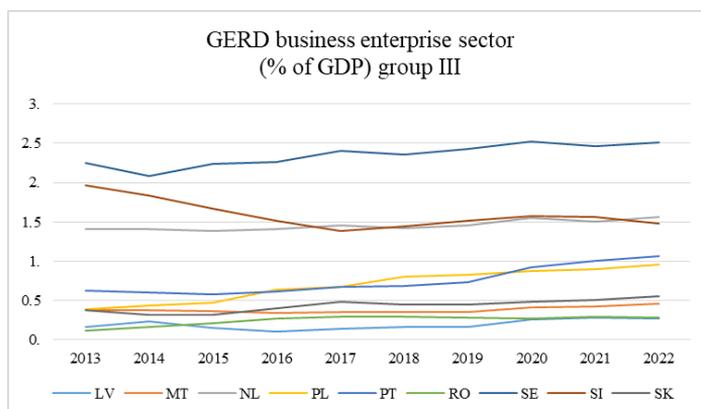


Fig. 6 The evolution of GERD in business enterprise sector (LV – SK)

In Figure 4 to Figure 6 we can see the GERD in business enterprise sector with the highest values in Sweden – GERD € [2.08%-2.52%], Belgium – GERD € [1.62%-2.53%], and Austria GERD € [2.09%-2.25%].

The lowest values are in Cyprus – GERD € [0.09%-0.37%], Romania – GERD € [0.12%-0.30%], and Latvia – GERD € [0.11%-0.29%].

3.3. Government sector

The next sector for which we calculated the rhythms with chain base for GERD in EU Countries was the government sector. You can see those results in Table 9 to Table 12.

Table 9 Rhythms with chain base – minimum and maximum values in government sector (a)

Country	AT	BE	BG	CY	CZ	DE	DK
MIN	0.828	3.704	-11.556	-15.011	-18.846	-12.314	-1.885
R	2020/2019	2020/2019	2016/2015	2016/2013	2016/2015	2022/2021	2014/2013
MAX	154.000	116.879	107.950	9.467	51.742	41.305	85.121
R	2022/2013	2022/2013	2022/2013	2019/2018	2022/2013	2021/2013	2022/2013

Table 10 Rhythms with chain base – minimum and maximum values in government sector (b)

Country	EE	EL	ES	FI	FR	HR	HU
MIN	-5.533	-8.455	-2.659	-18.947	-5.335	-7.105	-12.711
R	2016/2015	2016/2015	2016/2015	2016/2013	2020/2019	2016/2015	2016/2013
MAX	123.728	57.855	36.662	9.040	7.251	85.835	36.495
R	2022/2013	2022/2013	2022/2013	2017/2016	2022/2013	2022/2013	2022/2013

Table 11 Rhythms with chain base – minimum and maximum values in government sector (c)

Country	IE	IT	LT	LU	LV	MT	NL
MIN	-1.982	-1.662	-10.386	-8.105	-13.069	-93.519	-3.779
R	2016/2015	2015/2014	2018/2017	2016/2015	2016/2013	2016/2015	2022/2021
MAX	38.734	30.515	60.493	12.509	27.100	109.719	27.405
R	2022/2013	2022/2013	2017/2013	2015/2013	2022/2013	2015/2013	2021/2013

Table 12 Rhythms with chain base – minimum and maximum values in government sector (d)

Country	PL	PT	RO	SE	SI	SK
MIN	-90.303	-14.695	-10.028	-5.530	-10.992	-46.817
R	2016/2015	2016/2013	2014/2013	2015/2013	2014/2013	2016/2015
MAX	60.895	19.639	32.591	53.060	54.798	106.465
R	2020/2019	2022/2013	2022/2013	2021/2013	2022/2013	2015/2013

Analyzing the minimum values among the rhythms (R) with chain base we have the minimum value in Malta ($R_{2016/2015} = -93.519\%$ meaning that the value of GERD decreased with 93.519% from 2015

to 2016) and the maximum value in Belgium ($R_{2020/2019} = 3.704\%$ meaning that the value of GERD increased with 3.704% from 2019 to 2020).

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Analyzing the maximum values among the rhythms (R) with chain base we have the minimum value in France ($R_{2022/2013} = 7.251\%$ meaning that the value of GERD increased with 7.251% from 2013 to 2022) and the maximum value in Austria ($R_{2022/2013} = 154\%$ meaning that the value of GERD increased with 154% from 2013 to 2022).

In Romania we have the minimum value $R_{2014/2013} = -10.028\%$ meaning that the value of GERD decreased with 10.028% from 2013 to 2014 and the maximum value $R_{2022/2013} = 32.591\%$ meaning that the value of GERD increased with 32.591% from 2013 to 2022.

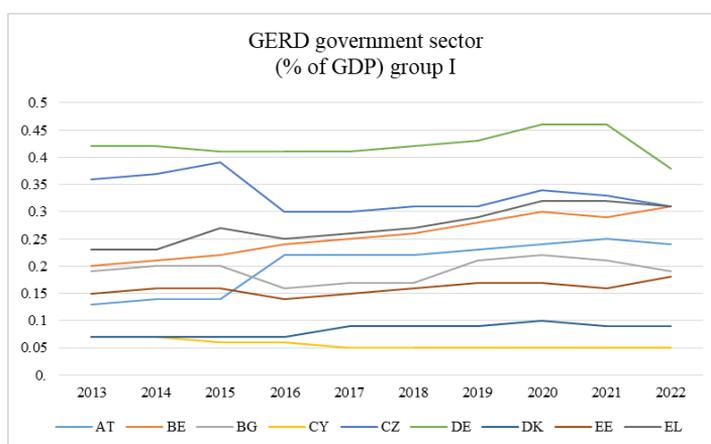


Fig. 7 The evolution of GERD in government sector (AT – EL)

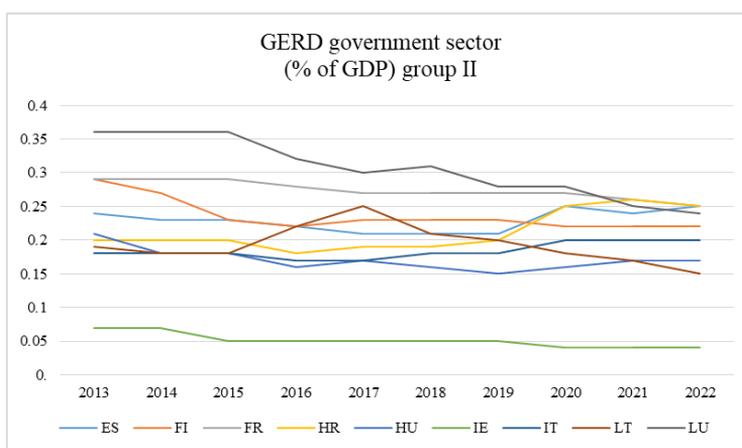


Fig. 8 The evolution of GERD in government sector (ES – LU)

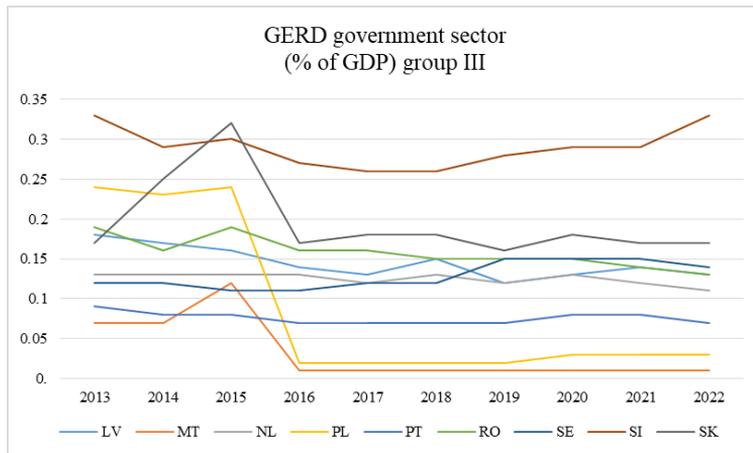


Fig. 9 The evolution of GERD in government sector (LV – SK)

The data of GERD for the Government sector are in Figure 7 to Figure 9. In Germany – GERD € [0.38%-0.46%], Czechia – GERD € [0.30%-0.39%], and Luxembourg – GERD € [0.24%-0.36%] are the highest values.

In Cyprus – GERD € [0.05%-0.07%], Ireland – GERD € [0.04%-0.07%], and Malta – GERD € [0.01%-

0.12%] are the lowest values. In Romania – GERD € [0.13%-0.19%].

3.4.Higher education sector

We calculated the rhythms with chain base in EU Countries also for GERD in higher education sector. You can see those results in Table 13 to Table 16.

Table 13 Rhythms with chain base – minimum and maximum values in higher education sector (a)

Country	AT	BE	BG	CY	CZ	DE	DK
MIN	0.332	-0.927	-21.675	-16.539	-25.730	2.772	-0.304
R	2016/2015	2014/2013	2015/2014	2016/2013	2016/2013	2015/2014	2014/2013
MAX	42.004	61.807	75.415	80.345	29.228	53.979	48.625
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

Table 14 Rhythms with chain base – minimum and maximum values in higher education sector (b)

Country	EE	EL	ES	FI	FR	HR	HU
MIN	-30.362	-13.113	-1.485	-0.604	-0.054	-5.459	-24.940
R	2016/2013	2016/2015	2016/2015	2015/2014	2014/2013	2017/2016	2016/2013
MAX	53.437	65.105	37.797	32.279	19.716	209.132	76.371
R	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

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Table 15 Rhythms with chain base – minimum and maximum values in higher education sector (c)

Country	IE	IT	LT	LU	LV	MT	NL
MIN	-15.535	-5.747	-41.056	-1.760	-36.111	-8.067	-2.026
R	2018/2017	2016/2013	2016/2015	2014/2013	2016/2015	2014/2013	2016/2015
MAX	23.064	7.854	38.389	67.624	126.964	67.325	46.628
R	2017/2013	2021/2020	2022/2013	2022/2013	2022/2013	2022/2013	2022/2013

Table 16 Rhythms with chain base – minimum and maximum values in higher education sector (d)

Country	PL	PT	RO	SE	SI	SK
MIN	1.618	-3.762	-32.114	-3.384	-10.775	-56.262
R	2020/2019	2020/2019	2016/2015	2019/2018	2015/2013	2016/2015
MAX	203.441	27.366	55.870	9.168	59.377	100.807
R	2022/2013	2022/2013	2015/2014	2021/2020	2022/2013	2015/2013

Analyzing the minimum values among the rhythms (R) with chain base we have the minimum value in Slovakia ($R_{2016/2015} = -56.262\%$ meaning that the value of GERD decreased with 56.262% from 2015 to 2016) and the maximum value in Germany ($R_{2015/2014} = 2.772\%$ meaning that the value of GERD increased with 30.89% from 2015 to 2016).

Analyzing the maximum values among the rhythms (R) with chain base we have the minimum value in Italy ($R_{2021/2020} = 7.854\%$ meaning

that the value of GERD increased with 7.854% from 2020 to 2021) and the maximum value in Croatia ($R_{2022/2013} = 209.132\%$ meaning that the value of GERD increased with 209.132% from 2013 to 2022).

In Romania we have the minimum value $R_{2016/2015} = -32.114\%$ meaning that the value of GERD decreased with 32.114% from 2015 to 2016 and the maximum value $R_{2015/2014} = 55.878\%$ meaning that the value of GERD increased with 55.878% from 2015 to 2014.

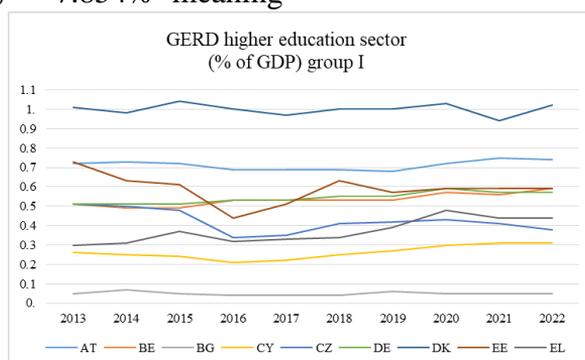


Fig. 10 The evolution of GERD in higher education sector (AT – EL)

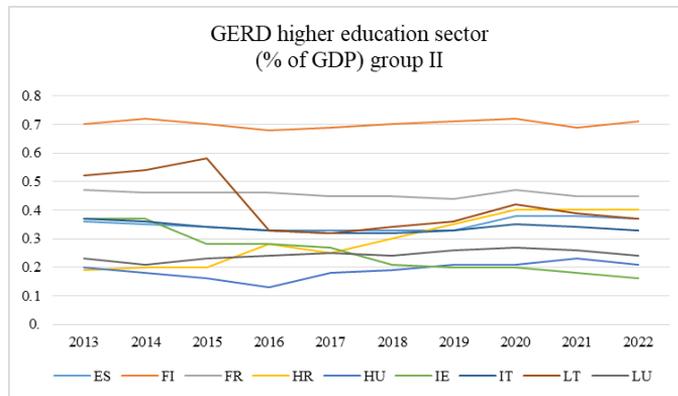


Fig. 11 The evolution of GERD in higher education sector (ES – LU)

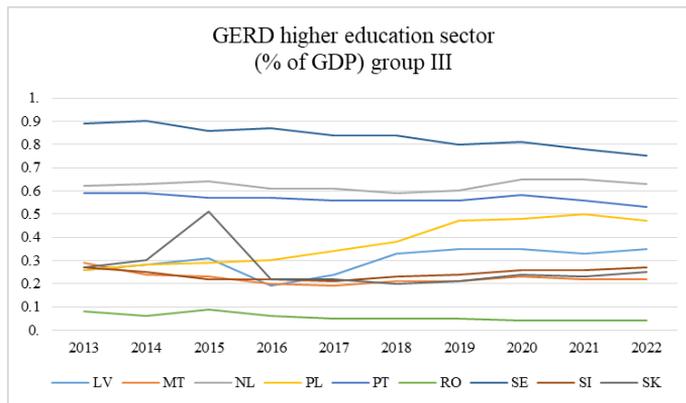


Fig. 12 The evolution of GERD in higher education sector (LV – SK)

In Figure 10 to Figure 12 we can see the data for GERD in the Higher education sector.

In Denmark – GERD € [0.94%-1.03%], Sweden – GERD € [0.75%-0.89%], and Austria – GERD € [0.68%-0.74%] are the highest values.

In Ireland – GERD € [0.16%-0.37%], Bulgaria – GERD € [0.04%-0.06%], and Romania – GERD € [0.04%-0.08%] are the lowest values.

3.5.Private non-profit sector

The last sector for which we calculated the rhythms with chain base in EU Countries was the private non-profit sector. You can see those results in Table 17 to Table 19. No available data for Germany, Croatia, Hungary, Ireland, Lithuania, Luxembourg, Latvia, Malta, and Netherlands.

Table 17 Rhythms with chain base – minimum and maximum values in private non-profit sector (a)

Country	AT	BE	BG	CY	CZ	DK
MIN	-2.718	-13.120	-52.751	-10.120	-41.918	-16.941
R	2021/2020	2021/2020	2016/2015	2015/2014	2016/2015	2017/2013
MAX	77.983	232.403	193.511	154.060	82.556	17.820
R	2022/2013	2019/2013	2017/2016	2022/2013	2022/2013	2019/2018

Table 18 Rhythms with chain base – minimum and maximum values in private non-profit sector (b)

Country	EE	EL	ES	FI	FR	IT
MIN	-37.161	-26.785	-6.250	-7.304	-2.153	-36.554
R	2022/2021	2020/2019	2017/2016	2022/2021	2017/2016	2018/2013
MAX	128.513	41.098	212.334	26.059	66.197	17.173
R	2020/2013	2018/2017	2022/2013	2019/2013	2022/2013	2019/2018

Table 19 Rhythms with chain base – minimum and maximum values in private non-profit sector (c)

Country	PL	PT	RO	SE	SI	SK
MIN	-41.558	-7.979	-18.777	-45.483	-46.257	-92.747
R	2015/2014	2015/2014	2016/2015	2018/2013	2018/2013	2019/2018
MAX	167.074	223.420	83.439	8.112	3101.070	298.373
R	2016/2015	2022/2013	2022/2013	2016/2015	2022/2013	2015/2013

Analyzing the minimum values among the rhythms (R) with chain base we have the minimum value in Slovakia ($R_{2019/2018} = -92.747\%$ meaning that the value of GERD decreased with 92.747% from 2018 to 2019) and the maximum value in France ($R_{2017/2016} = -2.153\%$ meaning that the value of GERD decreased with 2.153% from 2016 to 2017).

Analyzing the maximum values among the rhythms (R) with chain base we have the minimum value in Sweden ($R_{2016/2015} = 8.112\%$

meaning that the value of GERD increased with 8.112% from 2015 to 2016) and the maximum value in Slovenia ($R_{2022/2013} = 3101.07\%$ meaning that the value of GERD increased with 3101.07% from 2013 to 2022).

In Romania we have the minimum value $R_{2016/2015} = -18.777\%$ meaning that the value of GERD decreased with 18.777% from 2015 to 2016 and the maximum value $R_{2022/2013} = 83.439\%$ meaning that the value of GERD increased with 83.439% from 2013 to 2022.

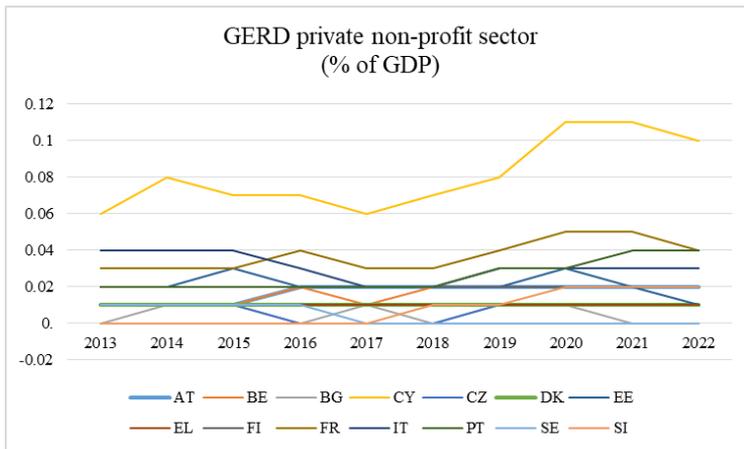


Fig. 13 The evolution of GERD in private non-profit sector (AT – SI)

In Figure 13 we can see the data for GERD in private non-profit sector.

The highest values are in Cyprus – GERD € [0.06%-0.11%], France – GERD € [0.03%-0.05%], and Portugal – GERD € [0.02%-0.04%].

The lowest values are in Greece – GERD € [0.01%-0.01%], Bulgaria – GERD € [0.00%-0.01%], and Sweden – GERD € [0.00%-0.01%] In Romania – GERD € [0.00%-0.00%].

4. CONCLUSIONS

The Gross Domestic Expenditure on R&D (GERD) in Romania has for all the sectors of activity presented here (business enterprise sector, government sector, higher education sector, and private non-profit sector) the lowest values among the EU Countries.

For the EU-27 – GERD € [2.1%-2.3%] for all sectors. For business enterprise sector in EU-27 we have GERD € [1.34%-1.51%].

For the government sector – GERD € [0.24%-0.27%], for higher education sector– GERD € [0.47%-0.50%], and for private non-profit sector – GERD € [0.01%-0.03%].

Romania needs more investments in all the sectors of activity, in order to have a successful development.

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