Final Project: The Change in GDP in the EU from 1995 - 2015

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This project will show how the GDP of countries on the European continent from 1995 through 2015. This project will show the effects of the monetary union on specific countries as well as the effects of the financial crisis. Some countries, such as Greece have struggled over the last ten years or so, and the path to where Greece is at today will be shown in this experiment.

The key element of this project will be data from the WOE, which gives GDP data for countries around the world. This data will give me access to the economic data I need for EU countries. Another key element will be GeoPandas, which will help me develop the heatmaps that I would like to present.

The project will have two sections:

- A Heat Map and Line Chart showing GDP for each country for each year from 1995 - 2018. This link shows what I will be trying to recreate, except each country will not have a number for GDP within it - the line chart will give the nominal GDP information.
- A movie (series of pictures that play automatically) showing each of these charts discussed above that will visualize the change in GDP for EU countries.

In [5]:
```
from IPython.display import display, Image # Displays things nicely
import pandas as pd # Key tool
import matplotlib.pyplot as plt # Helps plot
import numpy as np # Numerical operations
import os
import imageio

from descartes import PolygonPatch

#import fiona # Needed for geopandas to run
import geopandas as gpd # this is the main geopandas
from shapely.geometry import Point, Polygon # also needed

from mpl_toolkits.axes_grid1.inset_locator import zoomed_inset_axes
from mpl_toolkits.axes_grid1.inset_locator import mark_inset
```

Please note: All of the data is uploaded to the GitHub site. The map has also been uploaded to my github but you will need to download it to your local drive and add the path below so that the mapping and data will work:

- The data file called "WEO_Data" is for GDP data
- The data file called "WEO_Data_Per_Capita" is for per capita GDP Data
- The folder called "world" is for the europe map data

Please also note that when you run this, there will be outputs of pictures and gifs. Please update the paths below for where you would like the outputs to occur

I would like to give credit to Eurostat website for the shape file that I used and the WEO for the data that I used

The below lines are for the "WEO_Data":

In [6]:
```
gdp_file_name = "/Users/JoshRaj/School/04. Senior Year/02. Spring Seme
ster/Data Bootcamp/Final Project/WEO_Data.xlsx"
```

The below lines are for the "WEO_Data_Per_Capita

In [7]:
```
per_capita_file_name = "/Users/JoshRaj/School/04. Senior Year/02. Spri
ng Semester/Data Bootcamp/Final Project/WEO_Data_Per_Capita.xlsx"
```

The Below lines are for the map:

In [8]:
```
cwd = os.getcwd()

europe_shape = cwd + "/world/MyEurope.shx"

europe_shape
```

Out[8]:
```
'/Users/JoshRaj/School/04. Senior Year/02. Spring Semester/Data Boot
camp/Final Project/world/MyEurope.shx'
```

The below lines are for the output of the heat map pictures and gif only:

In [9]:
```
heatmapoutput = os.getcwd() + "/Picture/"
heatmapgifoutput = os.getcwd() + "/Picture/Movie.gif"
```

The below lines are for the output of the bargraph pictures and gif only:

In [10]:
```
barchartoutput = os.getcwd() + "/BarChart/"
barchartgifoutput = os.getcwd() + "/BarChart/Movie.gif"
```

The below lines are for the output of the combined GDP gifs

In [11]:
```
finaloutput = os.getcwd() + "/FinalOutput/"
finaloutputgif = os.getcwd() + "/FinalOutput/GDP.gif"
```

In [12]:
```
finaloutputgdplog = os.getcwd() + "/FinalOutput/GDPLog.gif"
```

In [13]:
```
finaloutputpercapitagif = os.getcwd() + "/FinalOutput/PerCapita.gif"
```

In [14]:
```
finaloutputpercapitaloggif = os.getcwd() + "/FinalOutput/PerCapitaLog.
gif"
```

Importing all essentials:

Overview: The data behind my prpject comes from the IMF World Economic Database, specifically from this link: http://data.imf.org/regular.aspx?key=62771448 (http://data.imf.org/regular.aspx?key=62771448). As mentioned above, this data gives worldwide GDP dating back to 1920, though I only the data till 1995. I will download the data and use it from my desktop

Below I am cleaning up the data:

Grabbing the data: Below I read the excel data then make a new data frame where I grab the data for the European countries that I would like to show on the map

In [15]:
```
gdp_data = pd.read_excel(gdp_file_name)
```

In [16]:
```
gdp_data
```

Out[16]:

	Country	Subject Descriptor	Units	Scale	Country/Series-specific Notes	1995	1996	1997
0	Afghanistan	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	NaN	NaN	NaN
1	Albania	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	2.882	3.200	2.259
2	Algeria	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	42.066	46.941	48.178
3	Angola	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	6.774	7.994	9.388
4	Antigua and Barbuda	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	0.577	0.634	0.681
5	Argentina	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	280.080	295.120	317.549
6	Armenia	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	1.287	1.597	1.639
7	Aruba	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	1.321	1.380	1.532
8	Australia	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	378.112	423.535	425.609
	Austria	Gross domestic product,	U.S.	Billions	See notes for: Gross domestic	241.235	237.343	213.045

9		current prices	dollars		product, curren...			
10	Azerbaijan	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	2.417	3.177	3.963
11	The Bahamas	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	5.653	5.950	6.332
12	Bahrain	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	6.787	7.057	7.318
13	Bangladesh	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	45.921	48.168	50.340
14	Barbados	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	2.229	2.377	2.513
15	Belarus	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	10.179	13.953	13.543
16	Belgium	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	289.844	281.447	255.132
17	Belize	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	0.620	0.641	0.654
18	Benin	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	2.190	2.379	2.286
19	Bhutan	Gross domestic product, current	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	0.296	0.311	0.348

		prices						
20	Bolivia	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	6.702	7.375	7.917
21	Bosnia and Herzegovina	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	NaN	3.584	4.578
22	Botswana	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	4.732	4.881	5.024
23	Brazil	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	786.536	850.415	884.308
24	Brunei Darussalam	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	5.255	5.679	5.769
25	Bulgaria	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	12.564	9.491	10.024
26	Burkina Faso	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	2.380	2.587	2.448
27	Burundi	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	1.000	0.868	0.972
28	Cabo Verde	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	0.536	0.553	0.540
29	Cambodia	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	3.441	3.507	3.443

...	...	...	...	...	...	...	...	...
166	Sweden	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	264.346	288.457	264.834
167	Switzerland	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	342.769	330.254	286.567
168	Syria	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	16.556	17.761	16.573
169	Taiwan Province of China	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	279.270	292.687	303.706
170	Tajikistan	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	0.569	1.052	1.121
171	Tanzania	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	4.251	5.311	6.415
172	Thailand	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	169.279	183.035	150.180
173	Timor-Leste	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	NaN	NaN	NaN
174	Togo	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	1.661	1.815	1.849
175	Tonga	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	0.213	0.234	0.220

176	Trinidad and Tobago	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	5.421	5.859	5.837	
177	Tunisia	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	19.654	21.283	20.747	
178	Turkey	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	233.340	250.263	261.775	
179	Turkmenistan	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	5.874	2.379	2.681	
180	Tuvalu	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	NaN	NaN	NaN	
181	Uganda	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	5.760	5.944	6.480	
182	Ukraine	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	38.275	46.083	51.867	
183	United Arab Emirates	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	63.637	70.991	76.171	
184	United Kingdom	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	1336.125	1410.853	1553.949	1
185	United States	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	7639.750	8073.125	8577.550	9
		Gross domestic			See notes for:				

186	Uruguay	product, current prices	U.S. dollars	Billions	Gross domestic product, curren...	21.312	22.657	23.974
187	Uzbekistan	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	10.168	13.923	14.704
188	Vanuatu	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	0.249	0.261	0.273
189	Venezuela	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	77.427	70.536	85.667
190	Vietnam	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	20.798	24.692	26.892
191	Yemen	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	12.796	6.496	6.838
192	Zambia	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	3.799	3.599	4.303
193	Zimbabwe	Gross domestic product, current prices	U.S. dollars	Billions	See notes for: Gross domestic product, curren...	7.152	8.758	8.990
194	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
195	International Monetary Fund, World Economic Ou...	NaN	NaN	NaN	NaN	NaN	NaN	NaN

196 rows × 30 columns

In [17]:
```
gdp_data = gdp_data.drop(["Subject Descriptor","Units","Scale","Country/Series-specific Notes"], axis=1)
```

In [18]:
```
gdp_data = gdp_data.set_index("Country")
```

Below, I am setting up the map of Europe:

In [19]:
```
europe_map = gpd.read_file(europe_shape)
```

In [20]:
```
europe_map.shape
```

Out[20]:
```
(33, 15)
```

In [21]:
```
europe_map.head(10)
```

Out[21]:

	FIPS_CNTRY	GMI_CNTRY	CNTRY_NAME	SOVEREIGN	POP_CNTRY	SQKM_CNTRY	SC
0	AL	ALB	Albania	Albania	3416945	28754.500	
1	AU	AUT	Austria	Austria	7755406	83738.852	
2	BE	BEL	Belgium	Belgium	10032460	30479.609	
3	BK	BIH	BosniaHerzegovina	Bosnia and Herzegovina	2656240	51403.379	
4	BU	BGR	Bulgaria	Bulgaria	8943258	110801.500	
5	DA	DNK	Denmark	Denmark	4667750	42670.711	
6	EI	IRL	Ireland	Ireland	5015975	69384.156	
7	EN	EST	Estonia	Estonia	1590808	45544.559	
8	EZ	CZE	CzechRepublic	Czech Republic	10321120	78495.156	
9	FR	FRA	France	France	57757060	546728.875	

In [22]:
```
europe_map = europe_map.set_index("SOVEREIGN")
```

In [23]:
```
europe_map["1995_GDP"] = gdp_data[1995]
```

In [24]:
```
europe_map
```

Out[24]:

SOVEREIGN	FIPS_CNTRY	GMI_CNTRY	CNTRY_NAME	POP_CNTRY	SQKM_CNTRY	SQM
Albania	AL	ALB	Albania	3416945	28754.500	

Austria	AU	AUT	Austria	7755406	83738.852	3
Belgium	BE	BEL	Belgium	10032460	30479.609	1
Bosnia and Herzegovina	BK	BIH	BosniaHerzegovina	2656240	51403.379	1
Bulgaria	BU	BGR	Bulgaria	8943258	110801.500	4
Denmark	DA	DNK	Denmark	4667750	42670.711	1
Ireland	EI	IRL	Ireland	5015975	69384.156	2
Estonia	EN	EST	Estonia	1590808	45544.559	1
Czech Republic	EZ	CZE	CzechRepublic	10321120	78495.156	3
France	FR	FRA	France	57757060	546728.875	21
Germany	GM	DEU	Germany	81436300	356108.812	13
Greece	GR	GRC	Greece	10307460	131851.906	5
Croatia	HR	HRV	Croatia	5004112	56287.789	2
Hungary	HU	HUN	Hungary	10310410	92782.203	3
Iceland	IC	ISL	Iceland	267240	101805.297	3
Italy	IT	ITA	Italy	57908880	300979.500	11

Latvia	LG	LVA	Latvia	2690291	64298.891	2
Lithuania	LH	LTU	Lithuania	3786560	64849.199	2
Slovakia	LO	SVK	Slovakia	5374362	48648.309	
Liechtenstein	LS	LIE	Liechtenstein	29342	164.800	
Luxembourg	LU	LUX	Luxembourg	387064	2594.117	
Moldova	MD	MDA	Moldova	4473570	33566.980	
Macedonia	MK	MKD	Macedonia	2104035	25321.289	
Monaco	MN	MCO	Monaco	27409	11.988	
Netherlands	NL	NLD	Netherlands	15447470	35492.691	
Poland	PL	POL	Poland	37911870	310715.094	1
Portugal	PO	PRT	Portugal	9625516	92098.273	3
Romania	RO	ROM	Romania	23540550	236654.000	9
Slovenia	SI	SVN	Slovenia	1951443	20245.689	
Spain	SP	ESP	Spain	39267780	505674.406	19
Sweden	SW	SWE	Sweden	8728217	443799.688	17
Switzerland	SZ	CHE	Switzerland	6713839	41178.398	

United Kingdom	UK	GBR	UnitedKingdom	56420180	243137.203	9

Adding all of the GDP data to Europe_Map then cleaning up the Map data:

In [25]:
```
year_list = [1995,1996,1997,1998,1999,2000,2001,2002,2003,2004,2005,20
06,2007,2008,2009,2010,2011,2012,2013,2014,2015]
```

In [26]:
```
for year in year_list:
    europe_map[year] = gdp_data[year]
```

In [27]:
```
for year in year_list:
    europe_map[str(year) + " log"] = np.log(gdp_data[year])
```

In [28]:
```
europe_map
```

Out[28]:

SOVEREIGN	FIPS_CNTRY	GMI_CNTRY	CNTRY_NAME	POP_CNTRY	SQKM_CNTRY	SQM
Albania	AL	ALB	Albania	3416945	28754.500	
Austria	AU	AUT	Austria	7755406	83738.852	3
Belgium	BE	BEL	Belgium	10032460	30479.609	
Bosnia and Herzegovina	BK	BIH	BosniaHerzegovina	2656240	51403.379	
Bulgaria	BU	BGR	Bulgaria	8943258	110801.500	4
Denmark	DA	DNK	Denmark	4667750	42670.711	
Ireland	EI	IRL	Ireland	5015975	69384.156	2
Estonia	EN	EST	Estonia	1590808	45544.559	
Czech Republic	EZ	CZE	CzechRepublic	10321120	78495.156	3
France	FR	FRA	France	57757060	546728.875	2
Germany	GM	DEU	Germany	81436300	356108.812	1
Greece	GR	GRC	Greece	10307460	131851.906	5
Croatia	HR	HRV	Croatia	5004112	56287.789	2

Hungary	HU	HUN	Hungary	10310410	92782.203	3
Iceland	IC	ISL	Iceland	267240	101805.297	3
Italy	IT	ITA	Italy	57908880	300979.500	1
Latvia	LG	LVA	Latvia	2690291	64298.891	2
Lithuania	LH	LTU	Lithuania	3786560	64849.199	2
Slovakia	LO	SVK	Slovakia	5374362	48648.309	
Liechtenstein	LS	LIE	Liechtenstein	29342	164.800	
Luxembourg	LU	LUX	Luxembourg	387064	2594.117	
Moldova	MD	MDA	Moldova	4473570	33566.980	
Macedonia	MK	MKD	Macedonia	2104035	25321.289	
Monaco	MN	MCO	Monaco	27409	11.988	
Netherlands	NL	NLD	Netherlands	15447470	35492.691	
Poland	PL	POL	Poland	37911870	310715.094	1
Portugal	PO	PRT	Portugal	9625516	92098.273	3
Romania	RO	ROM	Romania	23540550	236654.000	9
Slovenia	SI	SVN	Slovenia	1951443	20245.689	
Spain	SP	ESP	Spain	39267780	505674.406	1
Sweden	SW	SWE	Sweden	8728217	443799.688	1
Switzerland	SZ	CHE	Switzerland	6713839	41178.398	
United Kingdom	UK	GBR	UnitedKingdom	56420180	243137.203	9

33 rows × 57 columns

Setting up a dataframe that only includes data for the bar-chart (this strips out all map information):

In [29]:
```
bar_graph_df = europe_map
```

In [30]:
```
bar_graph_df = bar_graph_df.drop(columns = ['FIPS_CNTRY','GMI_CNTRY','
CNTRY_NAME','POP_CNTRY','SQKM_CNTRY','SQMI_CNTRY','CURR_TYPE','CURR_CO
DE', 'LANDLOCKED','COLOR_MAP','Pop2011CIA', 'Pop2000Wik','url','geomet
ry','1995_GDP'])
```

Adding the average GDP for each year to the bar_graph_GDP dataframe

In [31]:
```
bar_graph_df.loc['Average']=bar_graph_df.mean()
```

In [32]:
```
bar_graph_df = bar_graph_df.dropna(how = 'all')
```

In [33]:
```
bar_graph_df = bar_graph_df.sort_values(by = 1995, ascending = False)
```

In [34]:
```
bar_graph_df
```

Out[34]:

SOVEREIGN	1995	1996	1997	1998	1999	2000	2
Germany	2593.835000	2504.536000	2221.402	2246.306000	2202.792000	1955.283	1951.98
France	1602.130000	1606.035000	1454.555	1505.184000	1494.571000	1365.972	1377.40
United Kingdom	1336.125000	1410.853000	1553.949	1641.822000	1668.683000	1651.392	1626.21
Italy	1171.401000	1309.287000	1240.398	1267.956000	1250.171000	1144.880	1163.11
Spain	612.429000	638.444000	587.920	616.885000	634.369000	597.030	626.40
Netherlands	452.710000	450.625000	417.329	438.610000	447.474000	417.581	431.50
Average	350.073429	345.035966	325.034	336.097655	335.620241	312.231	315.22
Switzerland	342.769000	330.254000	286.567	294.824000	289.532000	272.192	278.67
Belgium	289.844000	281.447000	255.132	260.951000	260.538000	238.555	238.00
Sweden	264.346000	288.457000	264.834	267.225000	271.176000	260.157	240.28
Austria	241.235000	237.343000	213.045	218.557000	217.466000	197.338	197.47
Denmark	185.008000	187.633000	173.539	176.991000	177.964000	164.158	164.79
Poland	139.089000	156.684000	157.183	172.050000	167.799000	171.276	190.43
Greece	136.942000	145.872000	143.326	144.644000	149.412000	132.198	136.28
Portugal	118.194000	122.654000	117.241	124.159000	127.630000	118.682	121.62
Ireland	69.238000	75.904000	82.931	90.192000	98.826000	100.120	109.18
Czech Republic	59.768000	66.986000	61.783	66.465000	64.867000	61.645	67.52
Hungary	46.432000	46.660000	47.290	48.770000	49.170000	47.311	53.82
Romania	36.067000	35.921000	35.872	42.815000	36.183000	37.466	40.71

Croatia	22.388000	23.601000	23.974	25.346000	23.374000	21.774	23.29
Slovenia	21.304000	21.489000	20.791	22.147000	22.748000	20.446	20.90
Luxembourg	20.655000	20.548000	18.503	19.342000	21.173000	21.322	21.28
Bulgaria	12.564000	9.491000	10.024	13.227000	13.501000	13.153	14.07
Iceland	7.107000	7.449000	7.581	8.494000	8.972000	9.004	8.20
Lithuania	6.698000	8.385000	10.121	11.241000	10.973000	11.539	12.25
Latvia	5.410000	5.970000	6.527	7.178000	7.534000	7.941	8.35
Estonia	3.797000	4.745000	5.072	5.621000	5.741000	5.706	6.25
Albania	2.882000	3.200000	2.259	2.560000	3.209000	3.483	3.92
Moldova	1.689000	1.986000	2.260	1.989000	1.373000	1.541	1.73
Bosnia and Herzegovina	NaN	3.584000	4.578	5.281000	5.766000	5.554	5.78

30 rows × 42 columns

The function to make a heat map if given the year:

In [35]:
```
def make_plot(year, maxval):

    fig, ax = plt.subplots(figsize = (15,8))

    # First create the map for the urban share

    europe_map.plot(ax = ax, # So the geopandas has a built in plot fe
ature, we just pass our "ax to it
                edgecolor='tab:grey', # Tell it the edge color
                column=year,
                cmap="viridis",
                alpha= 0.9,
                vmin=0,
                vmax = maxval,
                legend=True) # Transparent
    ax.set_title(str(year)+" GDP")
    plt.savefig(heatmapoutput + str(year))
   # plt.show()
```

In [ ]:
```
make_plot(1995, 3500)
```

The for-loop below makes a map for every year from 1995-2015:

In [ ]:
```
for year in year_list:
    make_plot(year, 3500)
```

The below code is used to create the movie (GIF) that shows the change in GDP in the heat

map from 1995 - 2015:

In [38]:
```
year_pic_list = ["1995.png","1996.png","1997.png","1998.png",
                 "1999.png","2000.png","2001.png","2002.png",
                 "2003.png","2004.png","2005.png","2006.png",
                 "2007.png","2008.png","2009.png","2010.png","2011.png
",
                 "2012.png","2013.png","2014.png","2015.png"]

images = []
```

In [39]:
```
for filename in year_pic_list:
    images.append(imageio.imread(os.getcwd() + "/Picture/" + filename)
)
    imageio.mimsave(heatmapgifoutput, images, duration = 1)
```

The function to make a bar chart for the European countries:

In [40]:
```
def sort_barchart(y):
    bar_graph_df.sort_values(by = y, ascending = True, inplace=True)
```

In [41]:
```
def make_barchart(y):
    bar_graph_df.sort_values(by= y, ascending=True)
    fix, ax = plt.subplots(figsize = (10,25))
    ax.barh(bar_graph_df.index, bar_graph_df[y], color = 'blue')
    ax.set_xlim(0,4500)
    ax.set_title(str(y)+" GDP")
    plt.savefig(barchartoutput + str(y))
```

In [ ]:
```
sort_barchart(1997)
make_barchart(1997)
```

The For-Loop creates a bar chart for each year from 1995-2015:

In [ ]:
```
for year in year_list:
    sort_barchart(year)
    make_barchart(year)
```

The below code is used to create the movie (GIF) that shows the change in GDP in the bar

chart from 1995 - 2015:

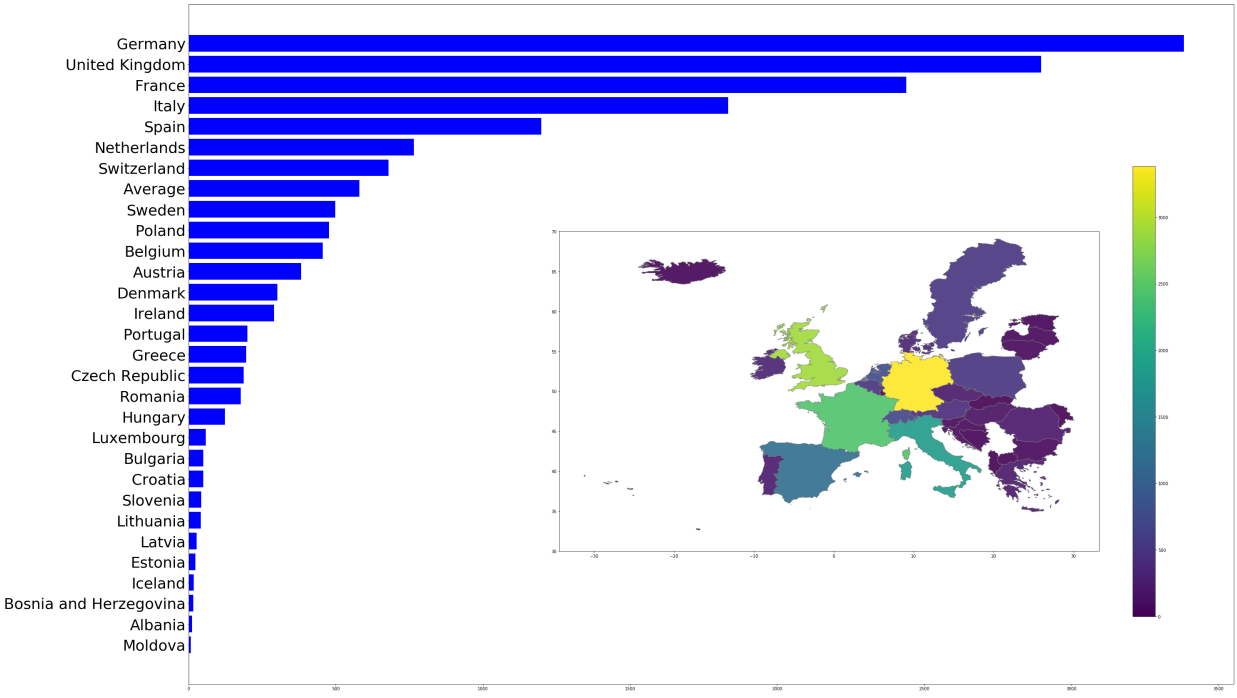
In [44]:
```
bimages = []
```

In [45]:
```
for filename in year_pic_list:
    bimages.append(imageio.imread(os.getcwd() + "/BarChart/" + filenam
e))
    imageio.mimsave(barchartgifoutput, bimages, duration = 1)
```

The below code combines the heat map and the bar-chart into one graph:

In [46]:
```
fig, ax1 = plt.subplots(figsize = (45,30))

left, bottom, width, height = [0.40, 0.2, 0.5, 0.5]
ax2 = fig.add_axes([left, bottom, width, height])



ax1.barh(bar_graph_df.index, bar_graph_df[2015], color = 'blue')
ax1.tick_params(axis ='y', which = 'major', labelsize = 36)
europe_map.plot(ax = ax2, # So the geopandas has a built in plot featu
re, we just pass our "ax to it
                edgecolor='tab:grey', # Tell it the edge color
                column=year,
                cmap="viridis",
                alpha= 0.9,
                vmin=0,
                legend=True)
ax2.set_ylim(30,70)
```

Out[46]: (30, 70)

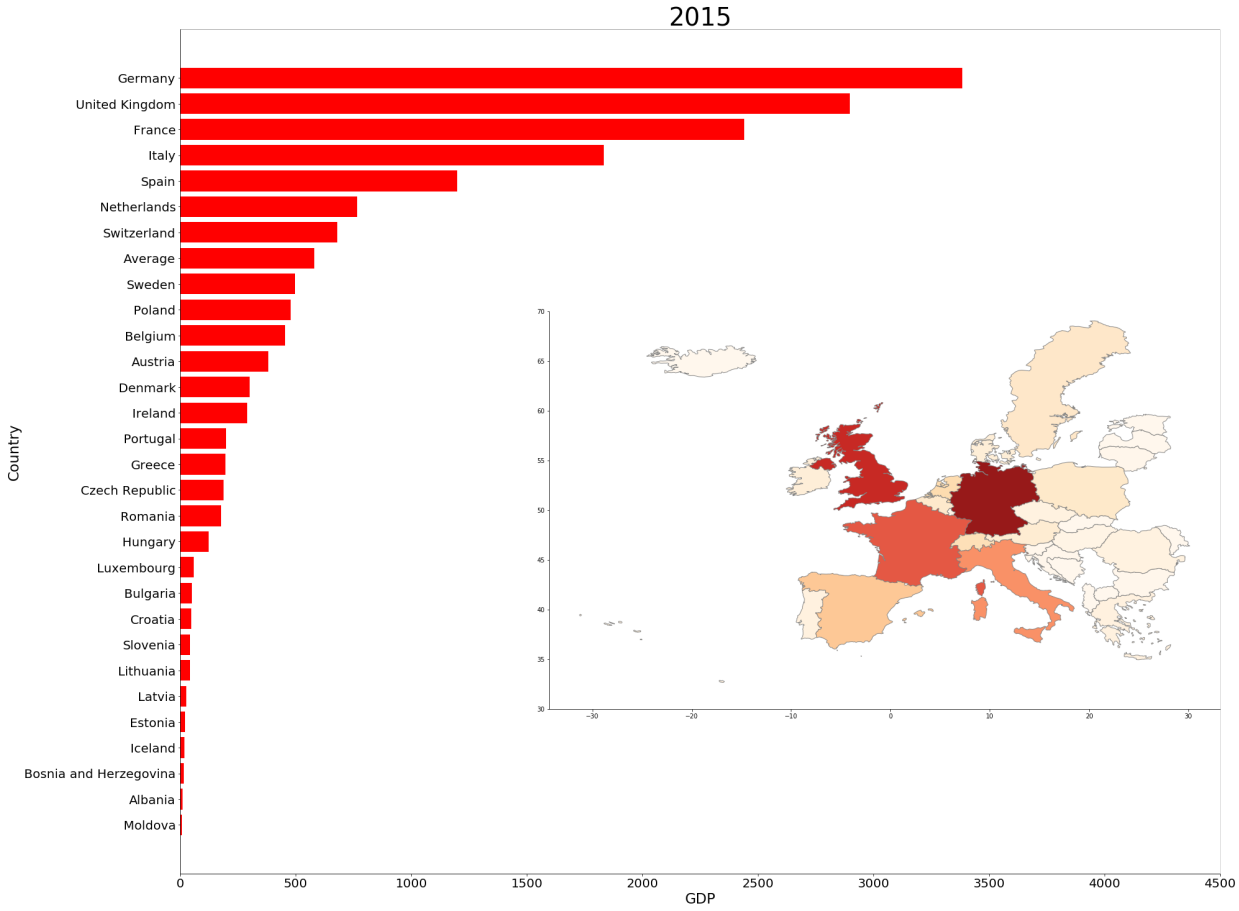


The below code is a function that allows us to make a combines chart for any year for the

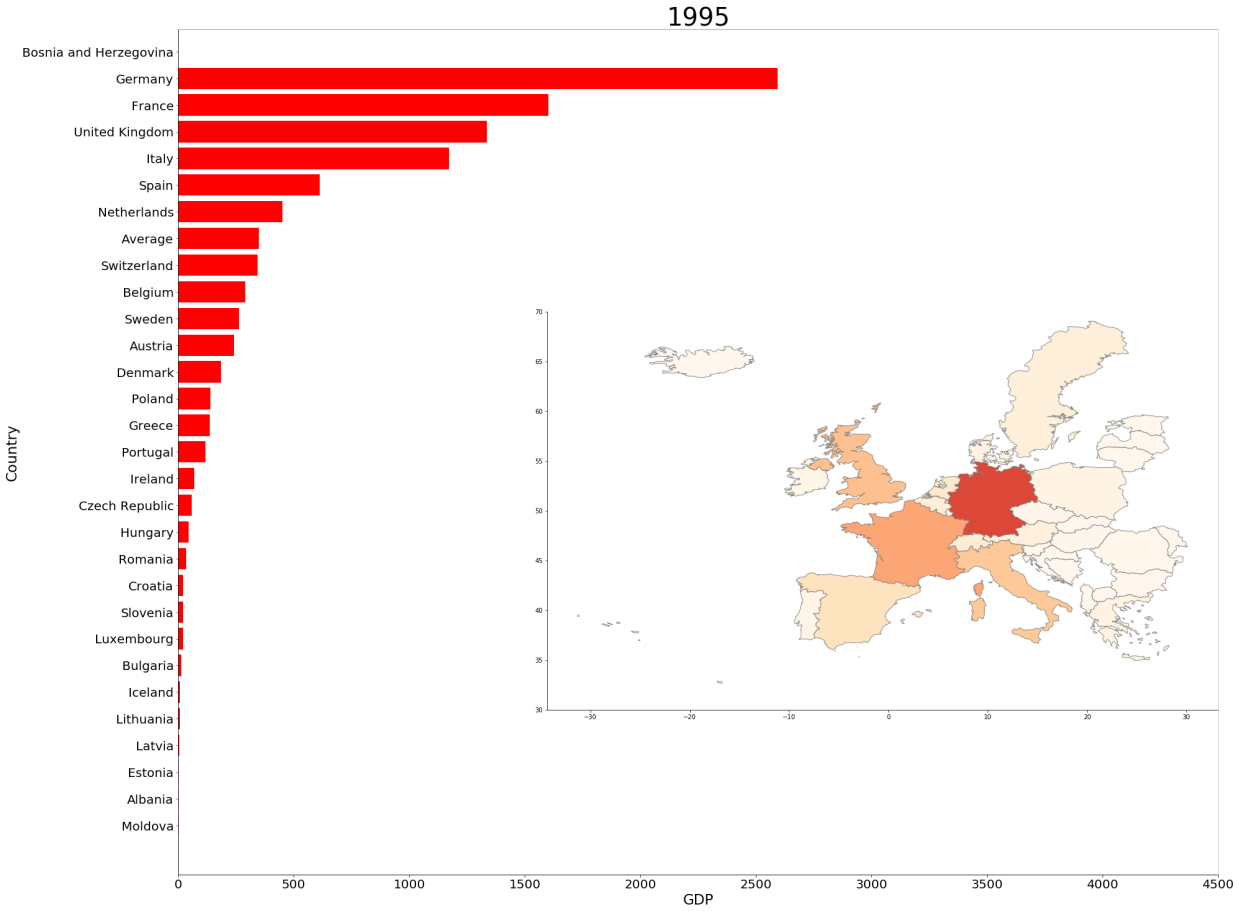
data that is provided:

In [47]:
```
def final_plot (y, mapmax, barmax):

    fig, ax1 = plt.subplots(figsize = (30,25))
    ax1.set_title (str(y), fontsize = 40)

    left, bottom, width, height = [0.40, 0.2, 0.5, 0.5]
    ax2 = fig.add_axes([left, bottom, width, height])

    ax1.barh(bar_graph_df.index, bar_graph_df[y], color = 'r')
    ax1.tick_params(axis ='both', which = 'major', labelsize = 20)
    ax1.set_xlim(0,barmax) #4500
    ax1.set_ylabel("Country", fontsize = 23,) # The ylable
    ax1.set_xlabel("GDP", fontsize = 23) # the xlable
    ax1.spines["right"].set_visible(False) # This removes the ``spines
'', just the right and top
    ax1.spines["top"].set_visible(False)


    europe_map.plot(ax = ax2, # So the geopandas has a built in plot f
eature, we just pass our "ax to it
                edgecolor='tab:grey', # Tell it the edge color
                column= y,
                cmap="OrRd",
                alpha= 0.9,
                vmin=0,
                vmax = mapmax, #3500
                legend=False)
    ax2.set_ylim(30,70)
    ax2.spines["right"].set_visible(False) # This removes the ``spines
'', just the right and top
    ax2.spines["top"].set_visible(False)



    plt.savefig(finaloutput+ str(y))
```

In [48]:
```
sort_barchart(2015)
final_plot(2015, 3500, 4500)
```



In [49]:
```
for year in year_list:
    sort_barchart(year)
    final_plot(year, 3500,4500)
```


1995
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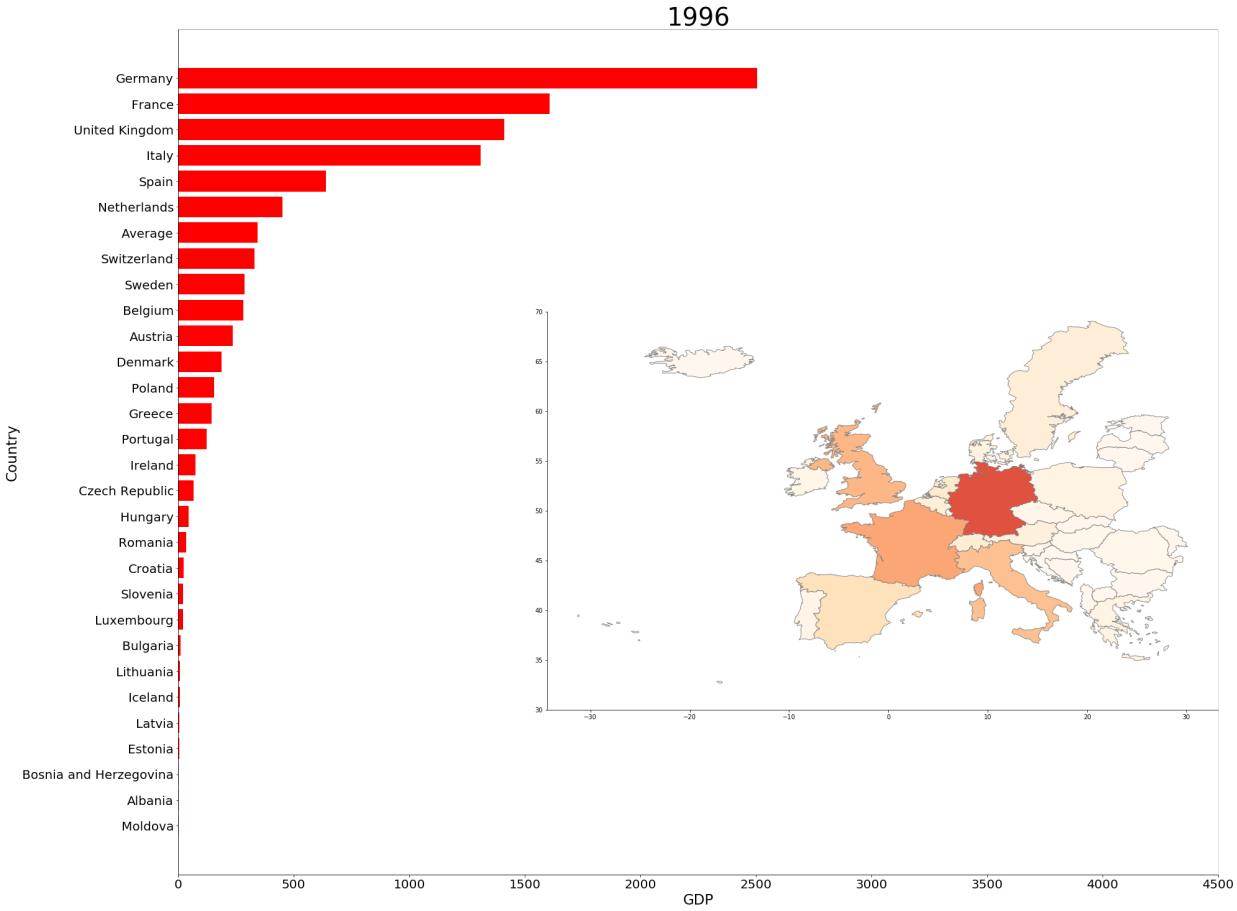
1996
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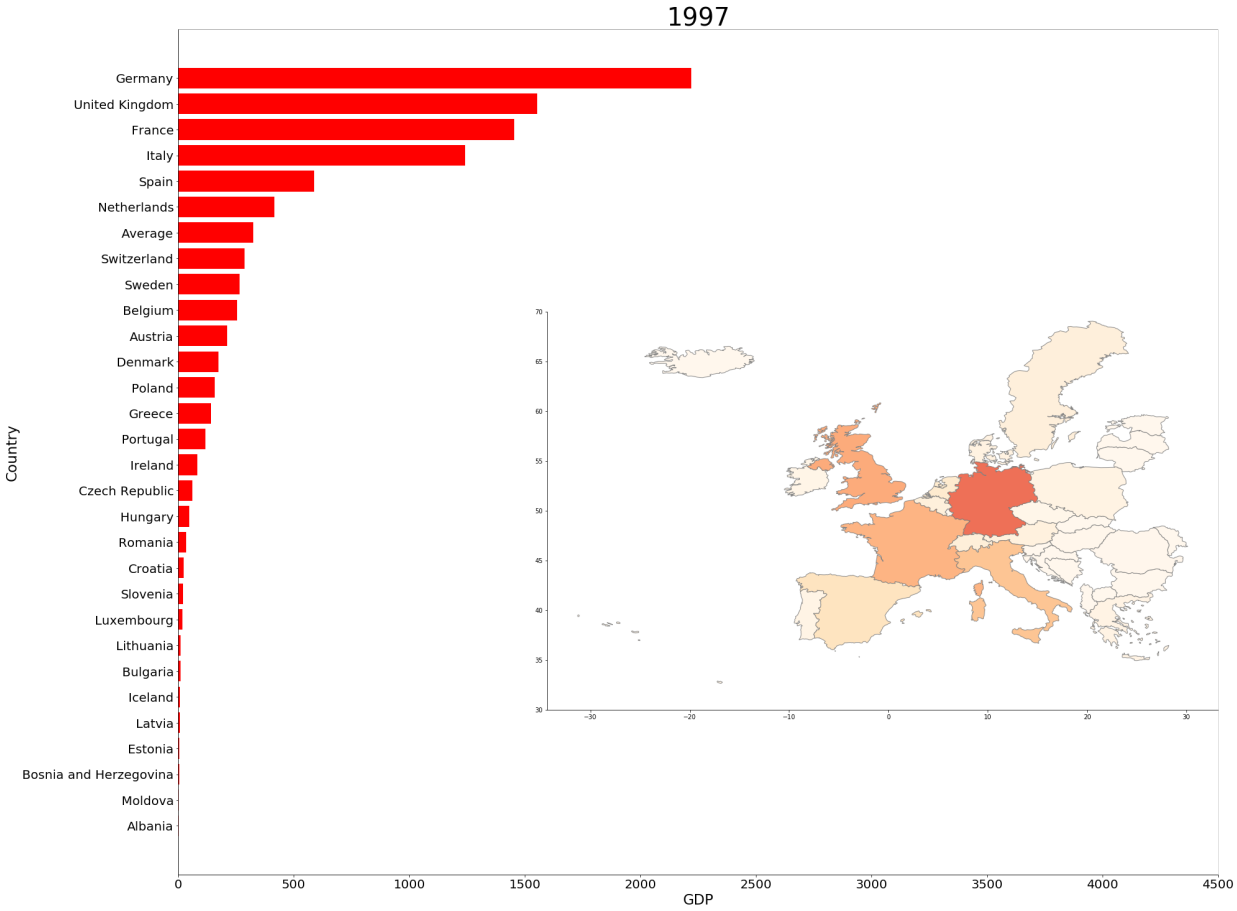
1997
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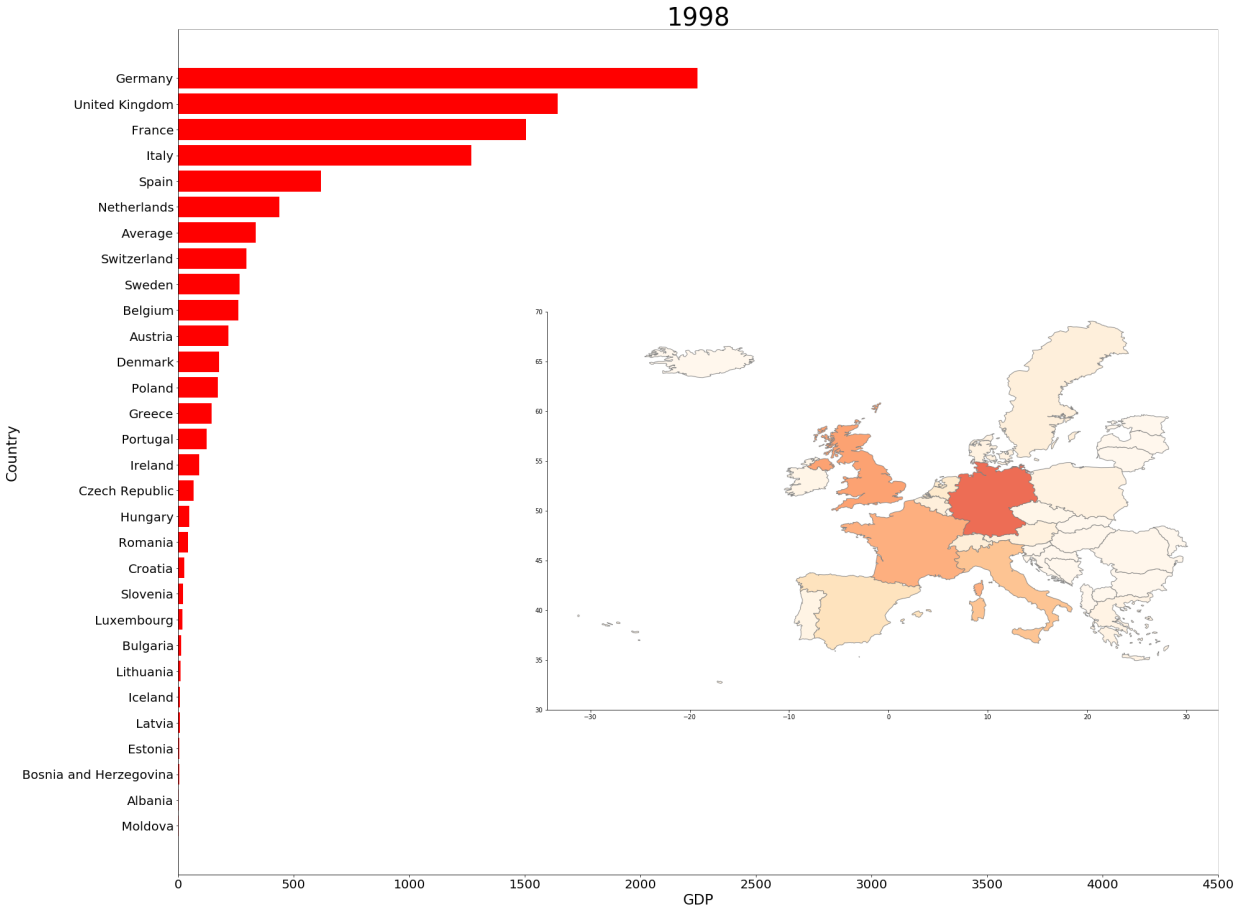
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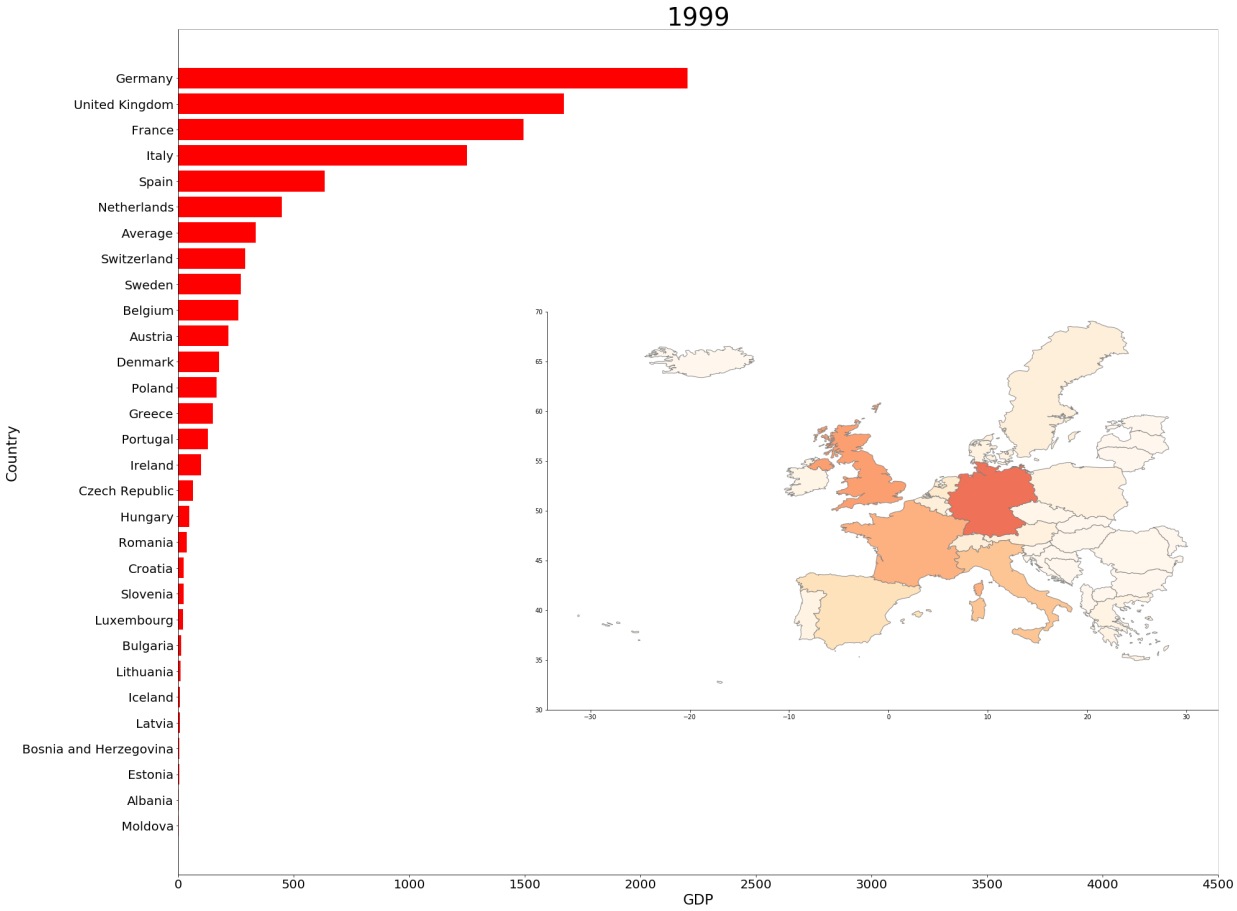
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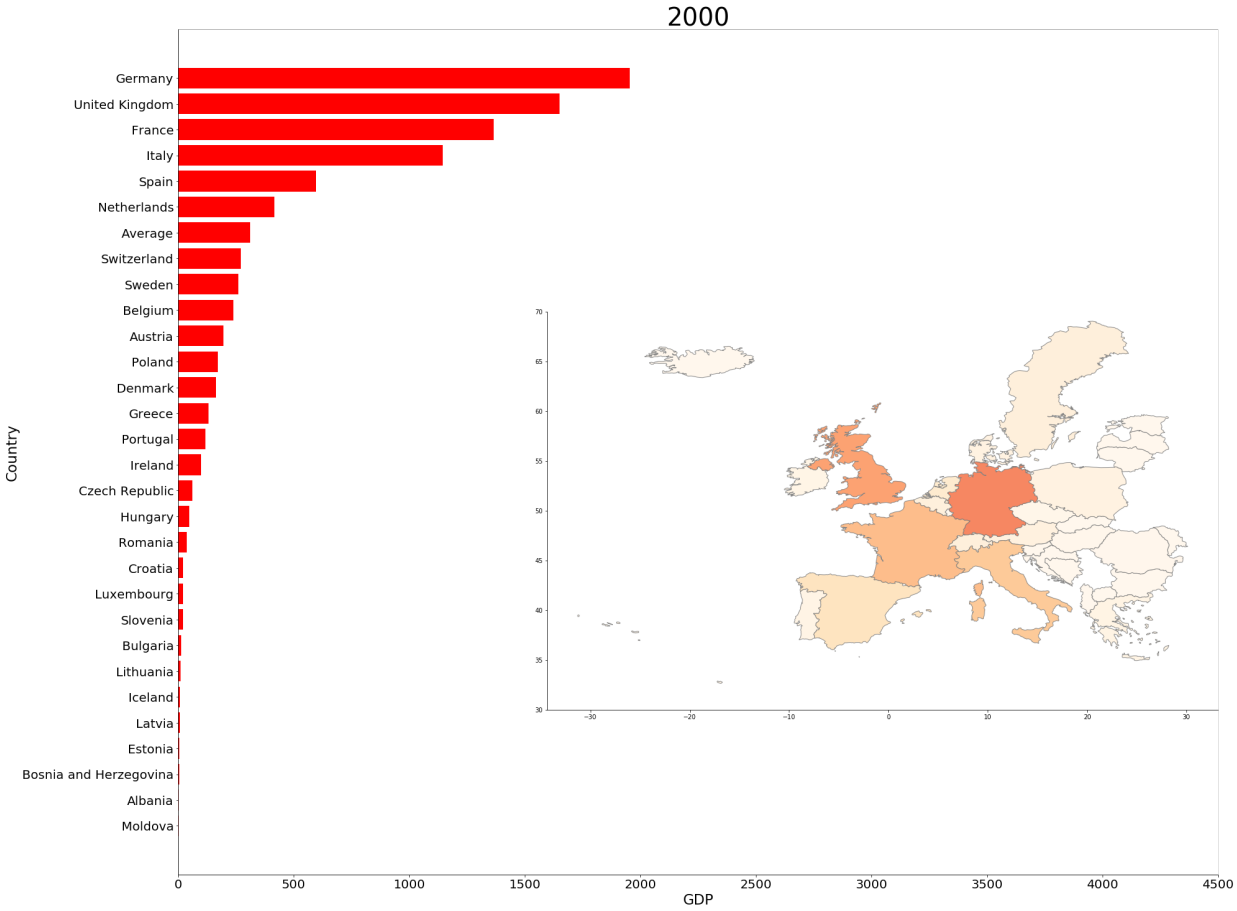
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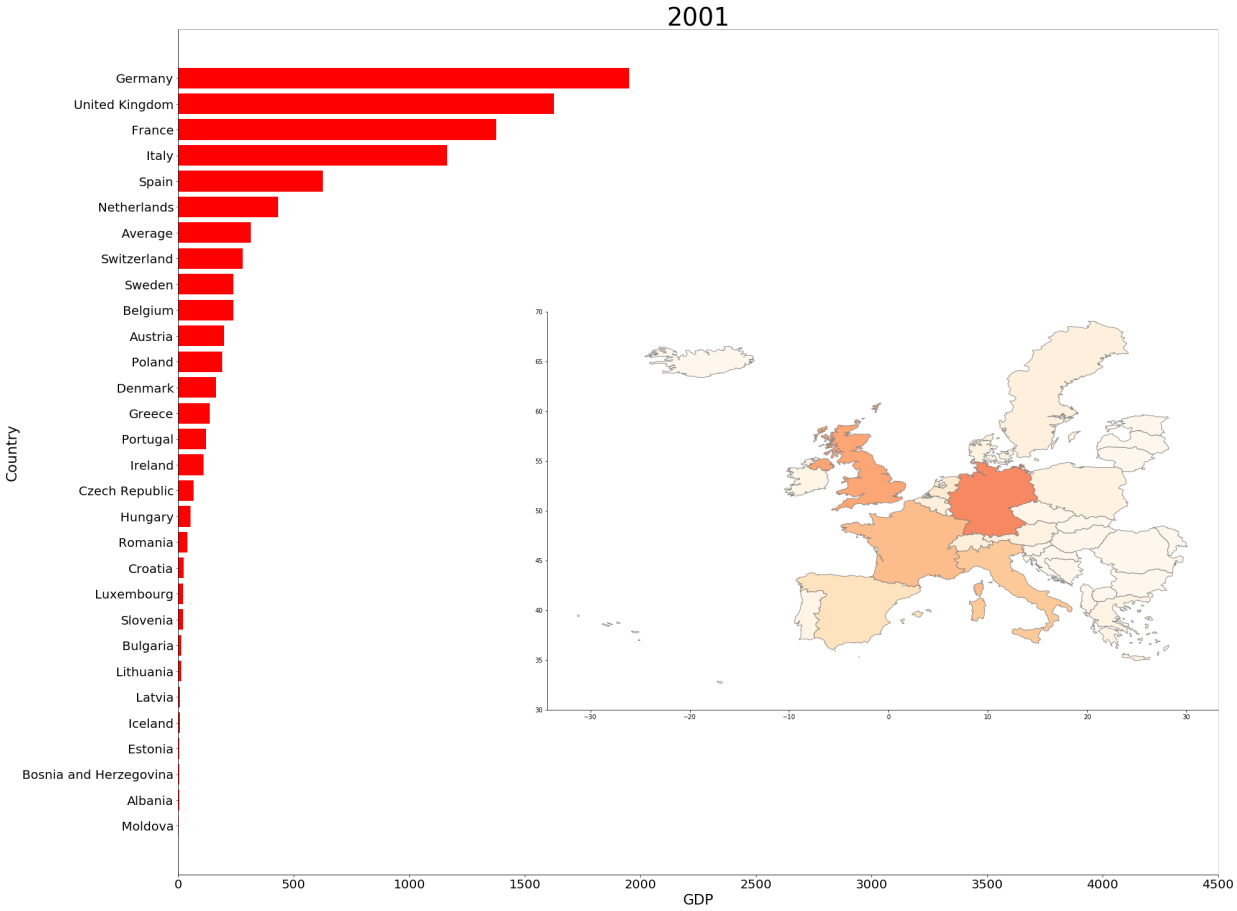
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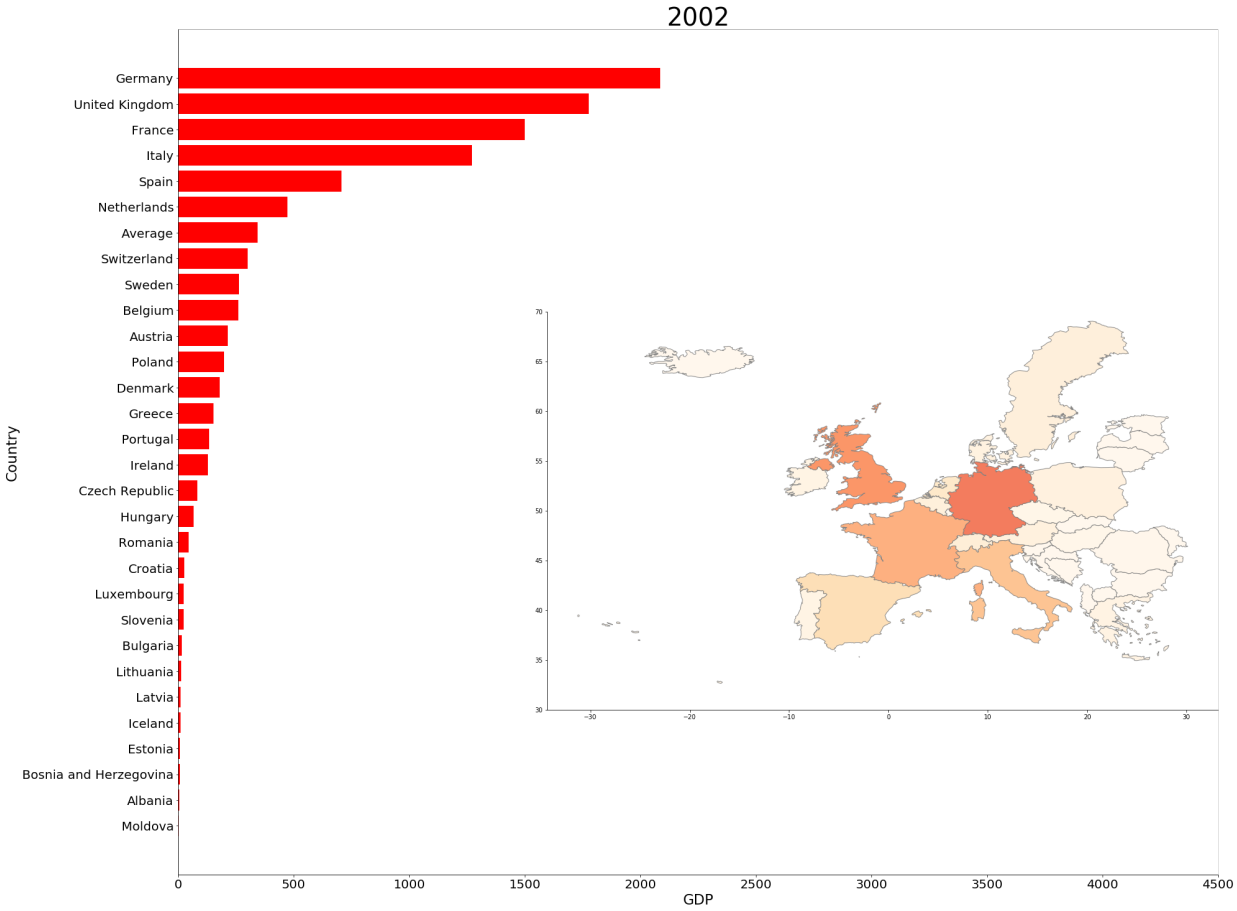
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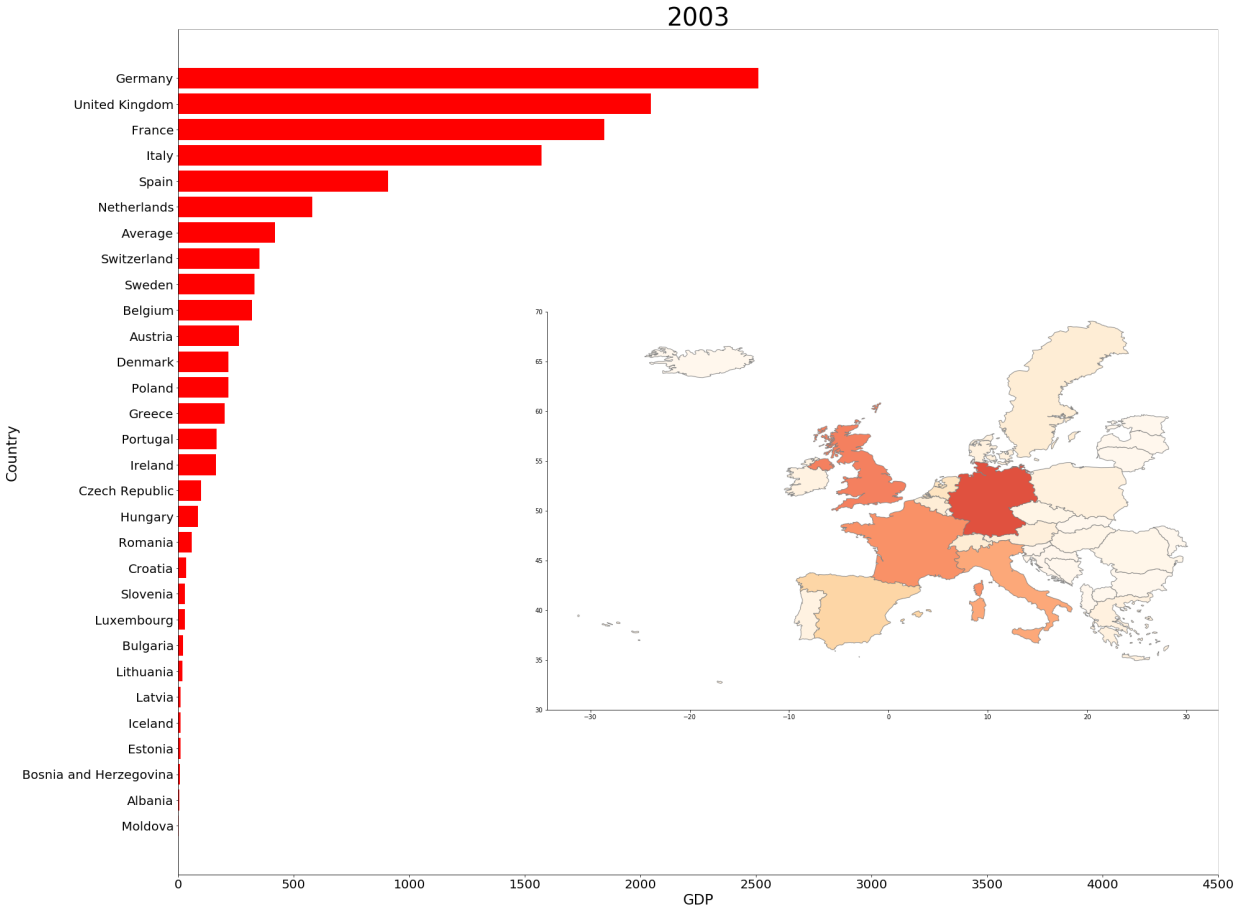
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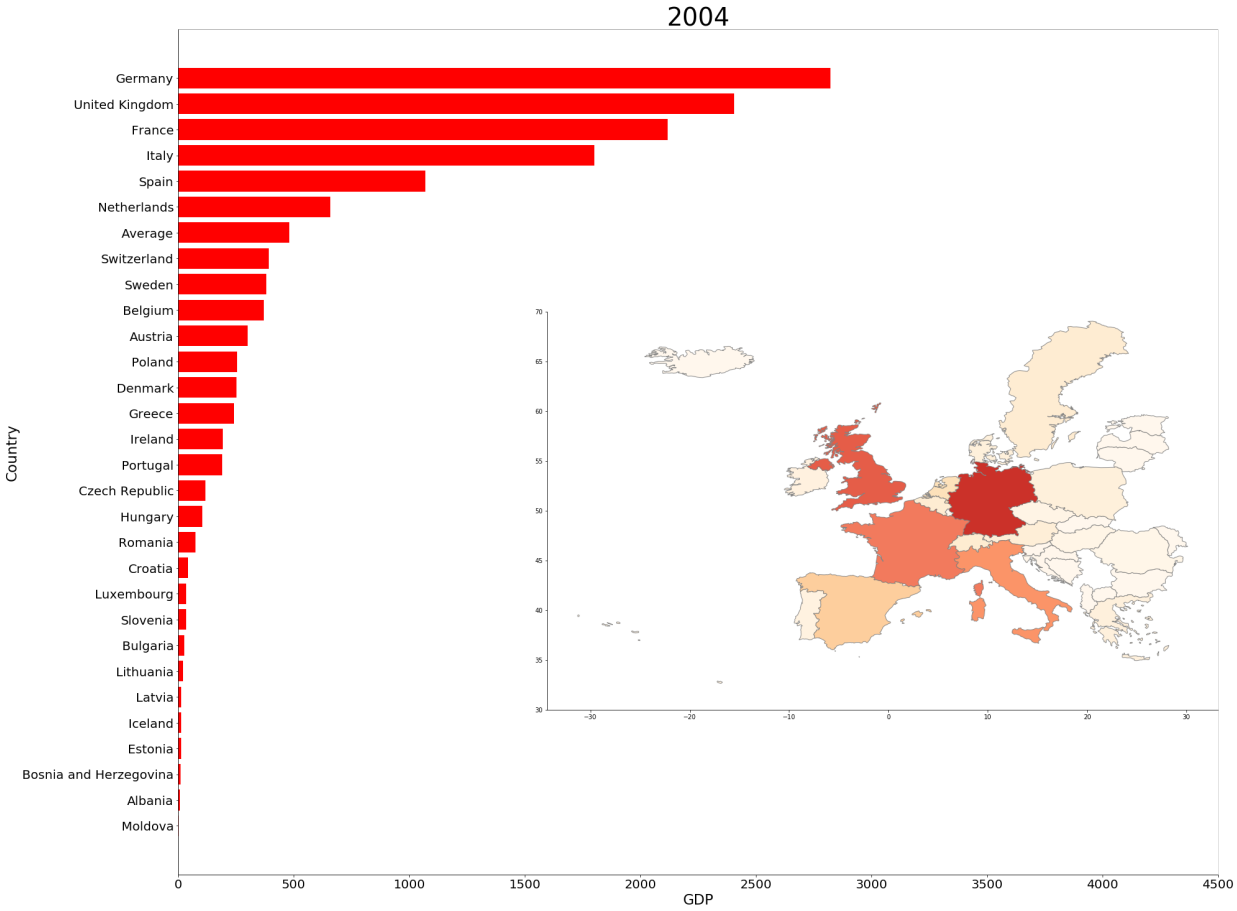
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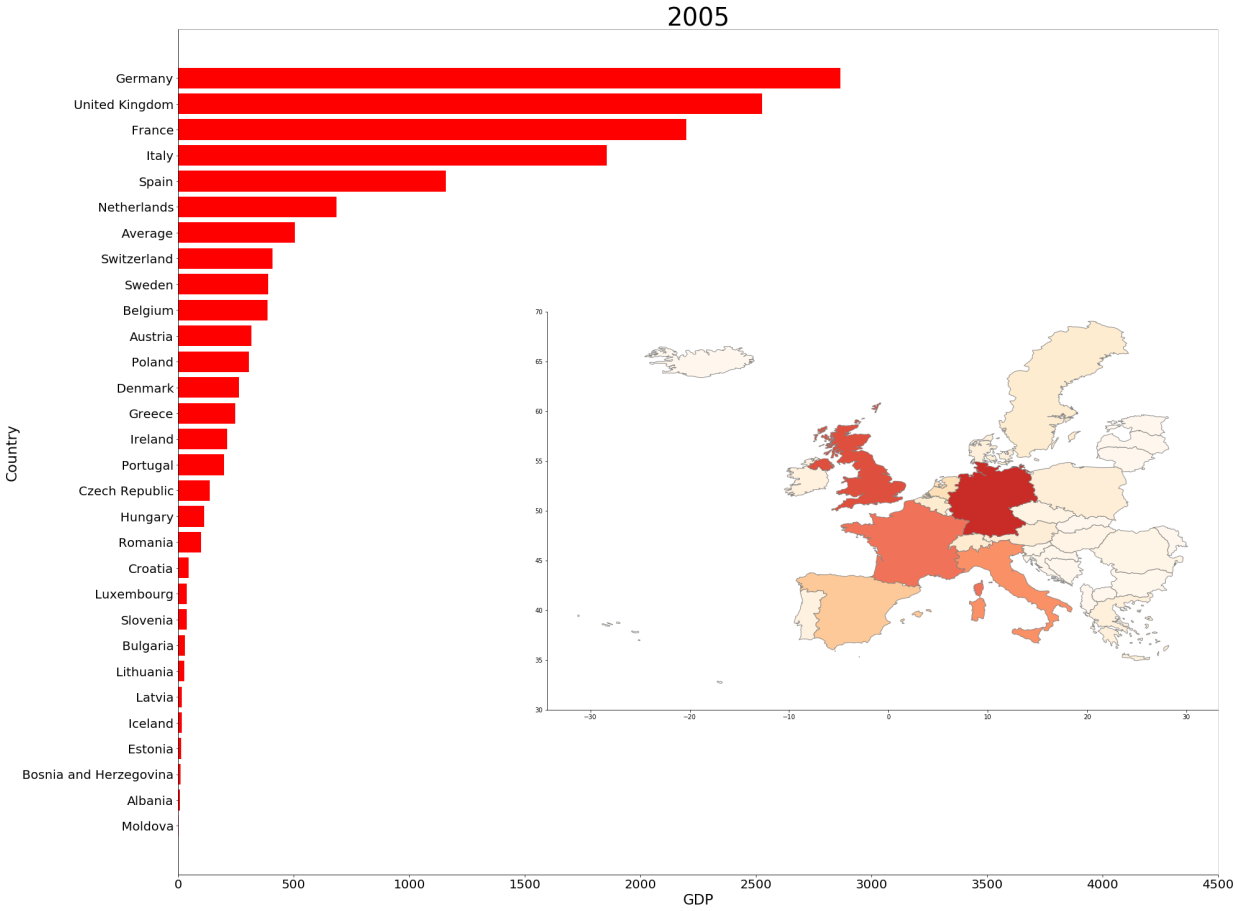
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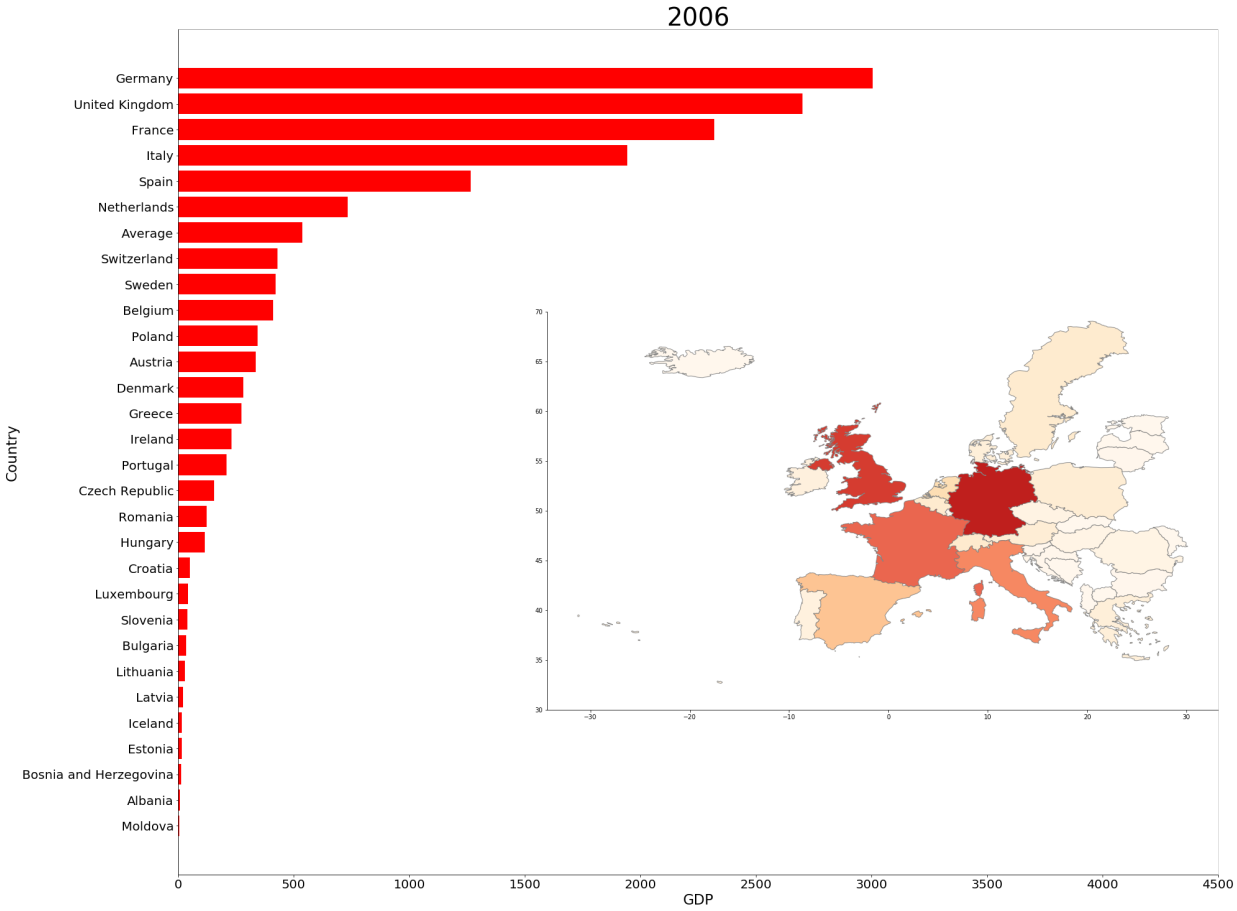
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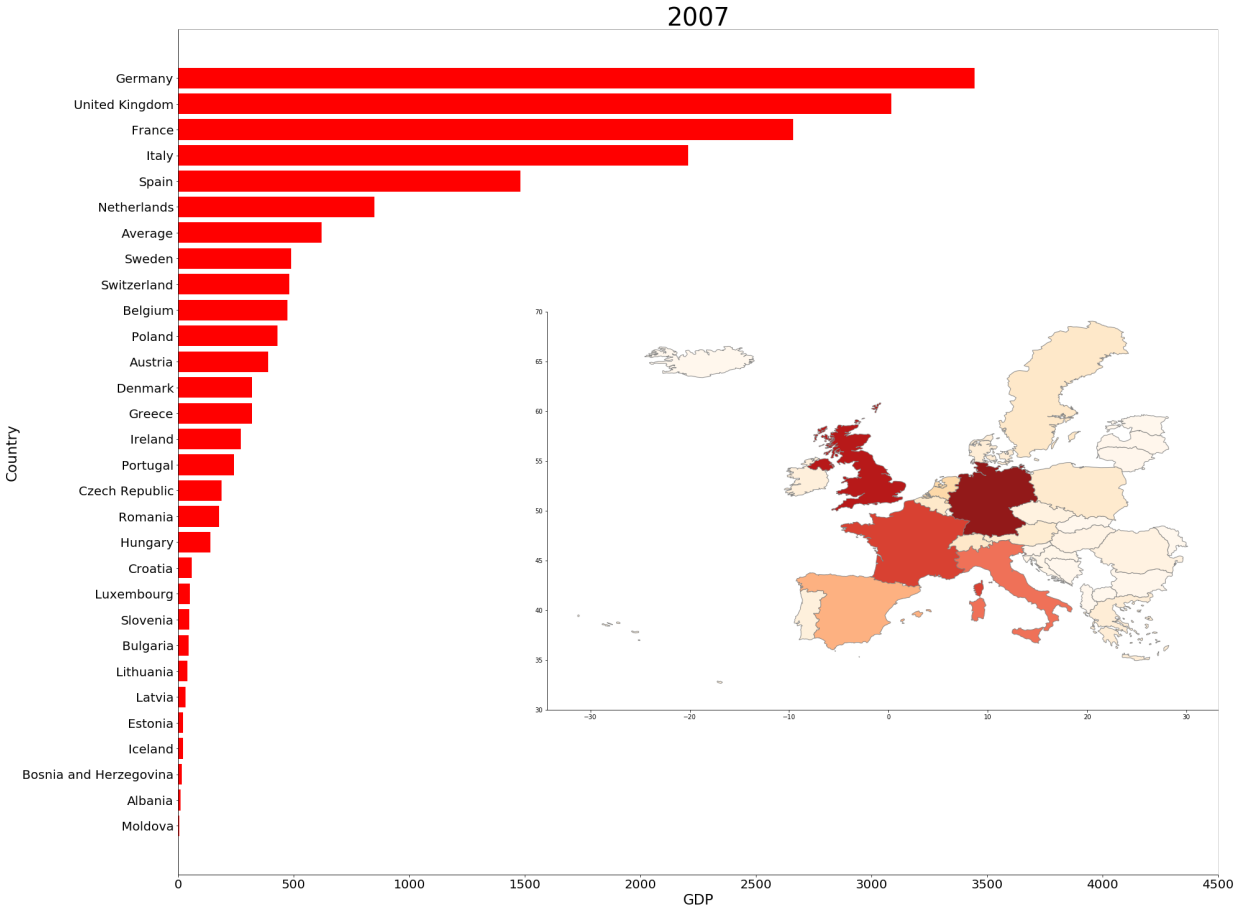
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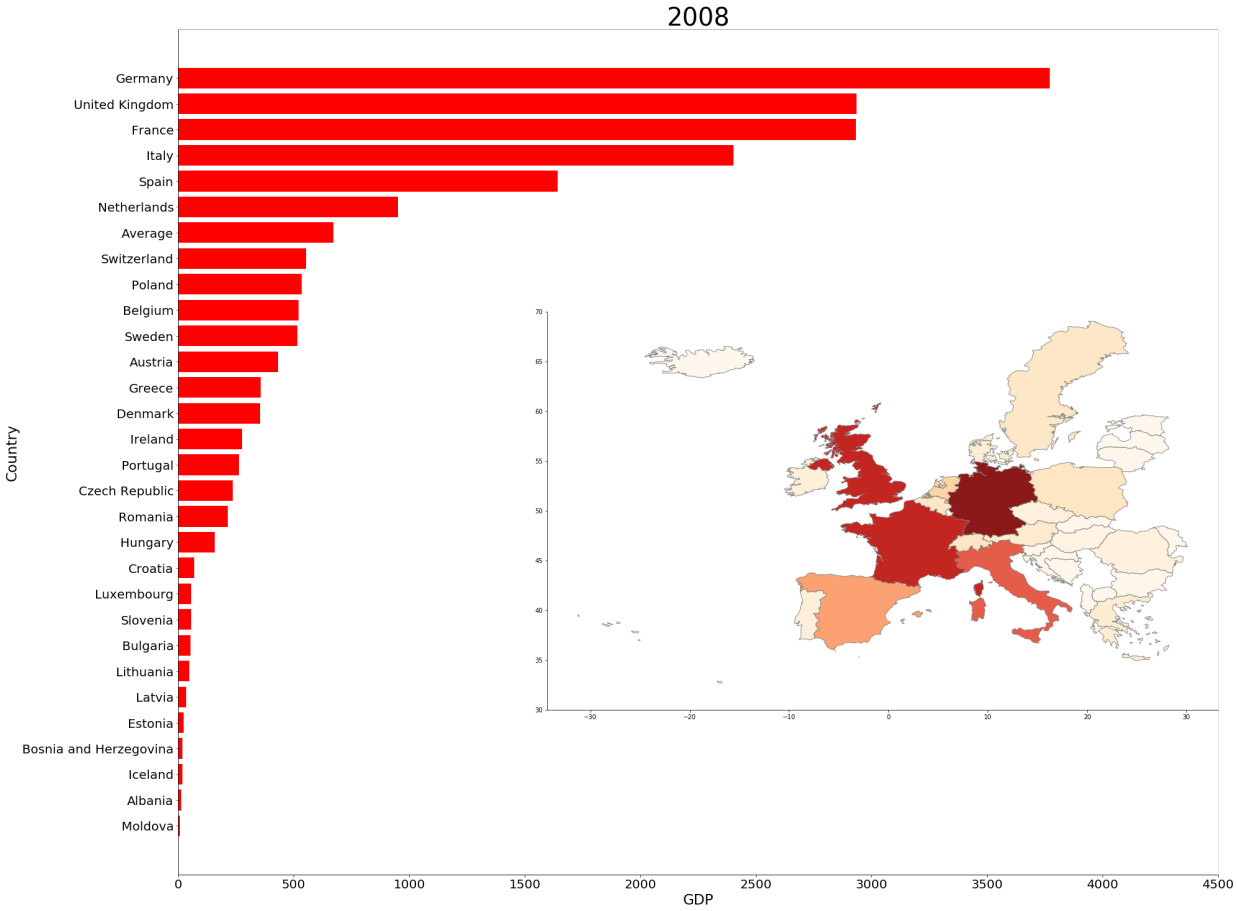
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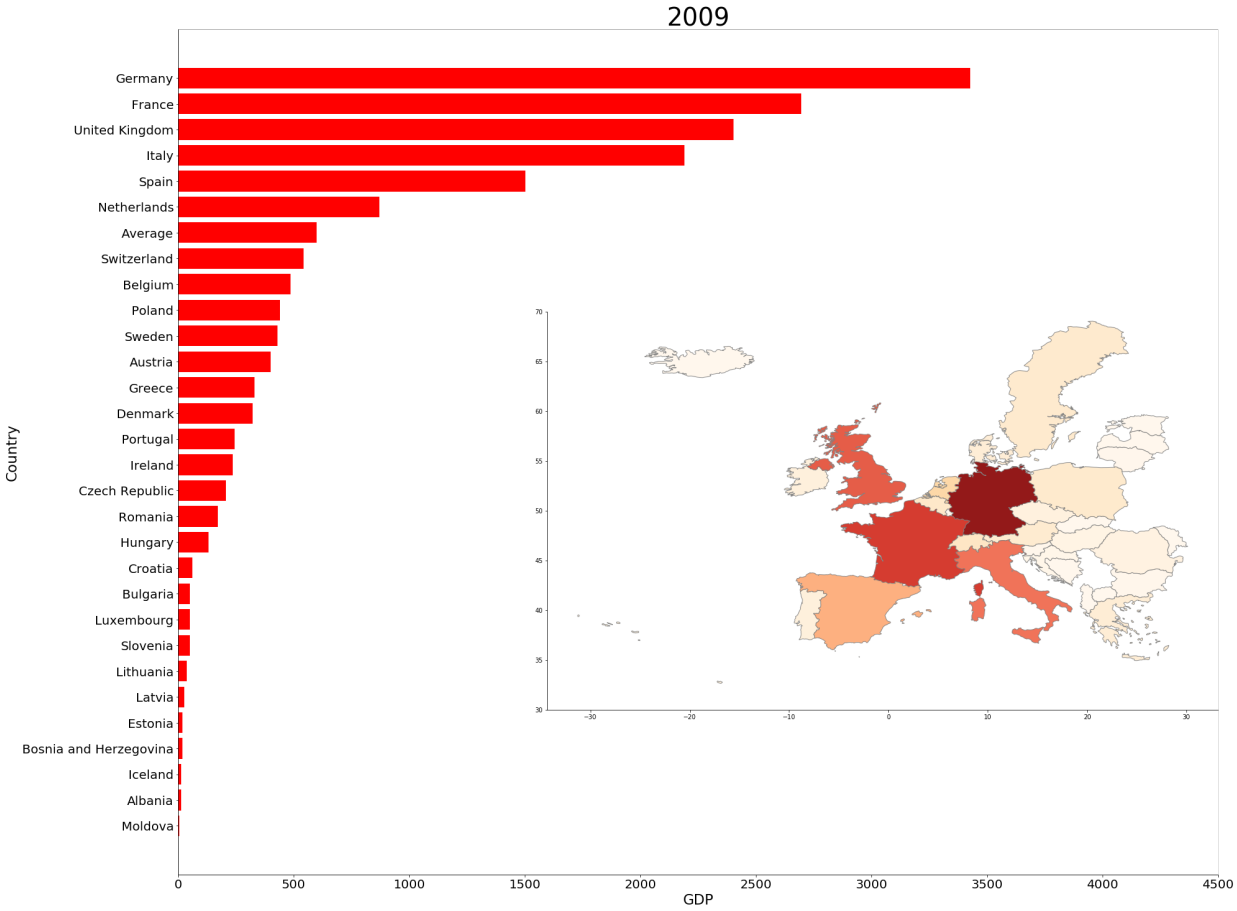
2009
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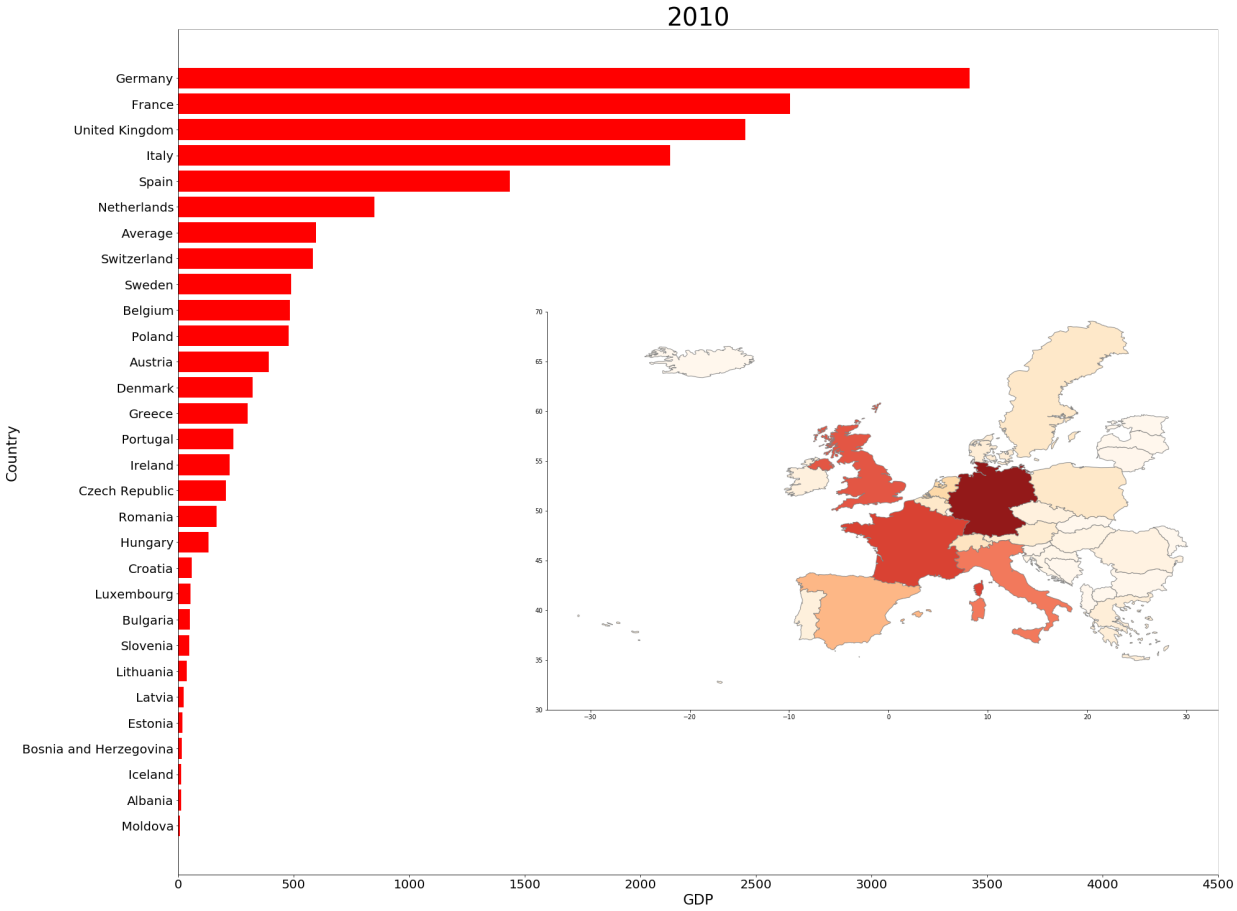
2010
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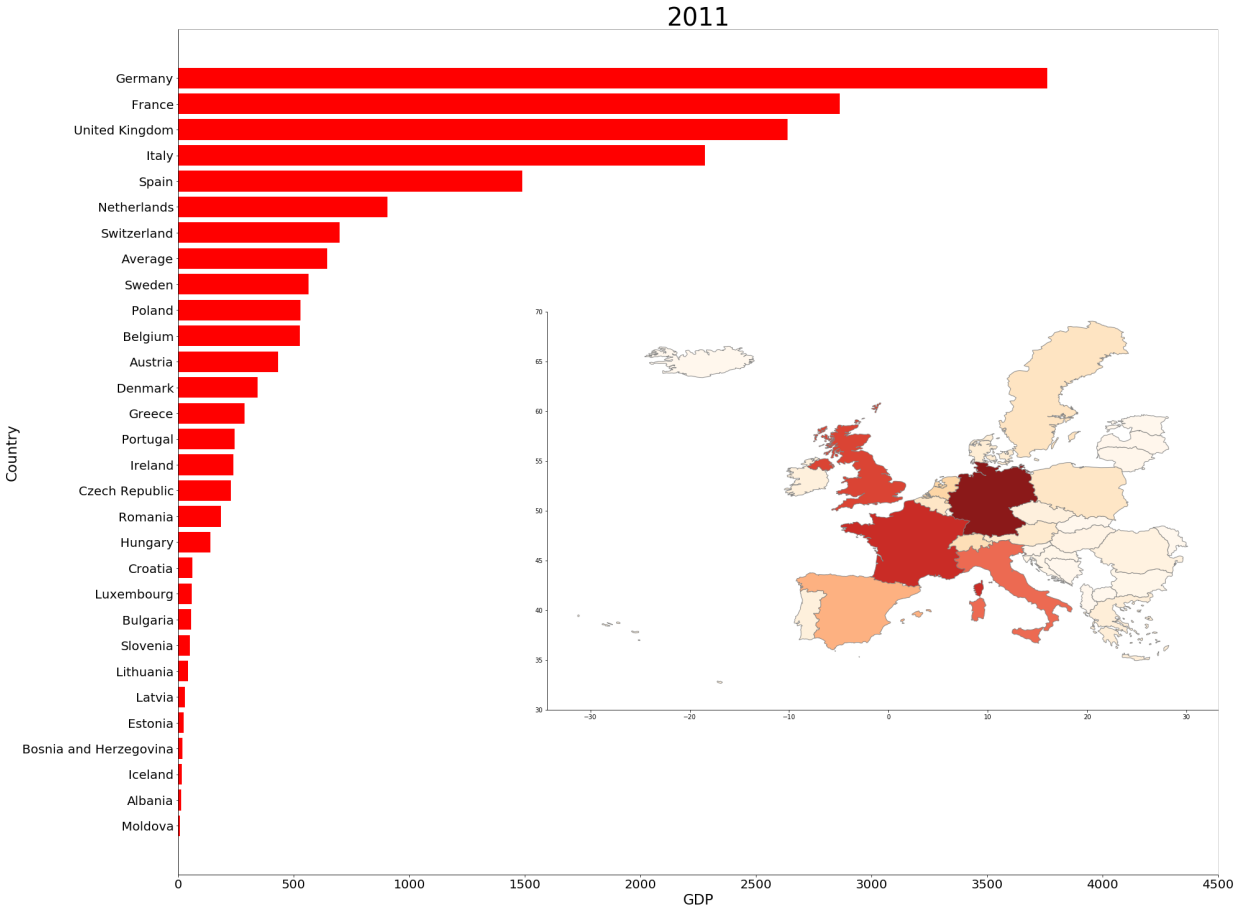
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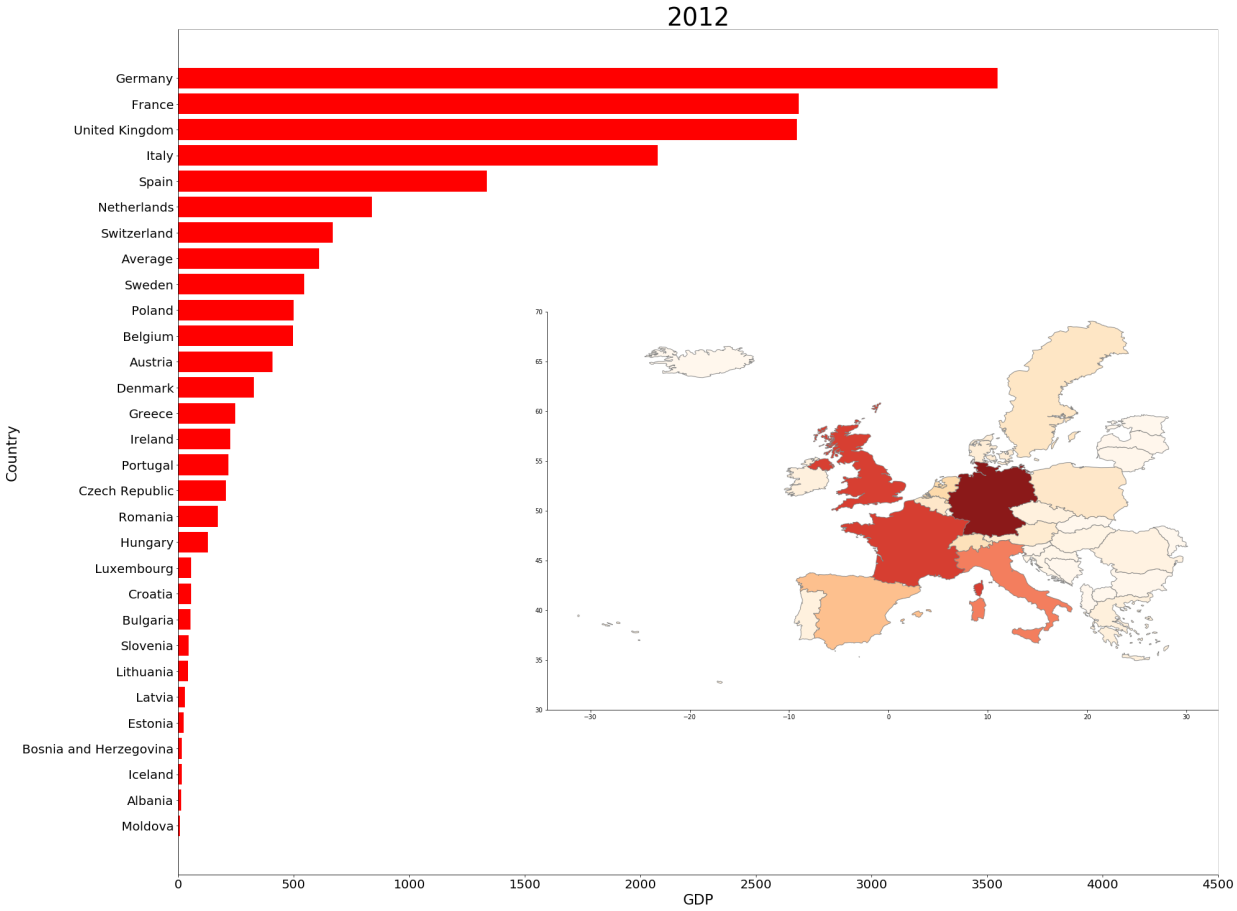
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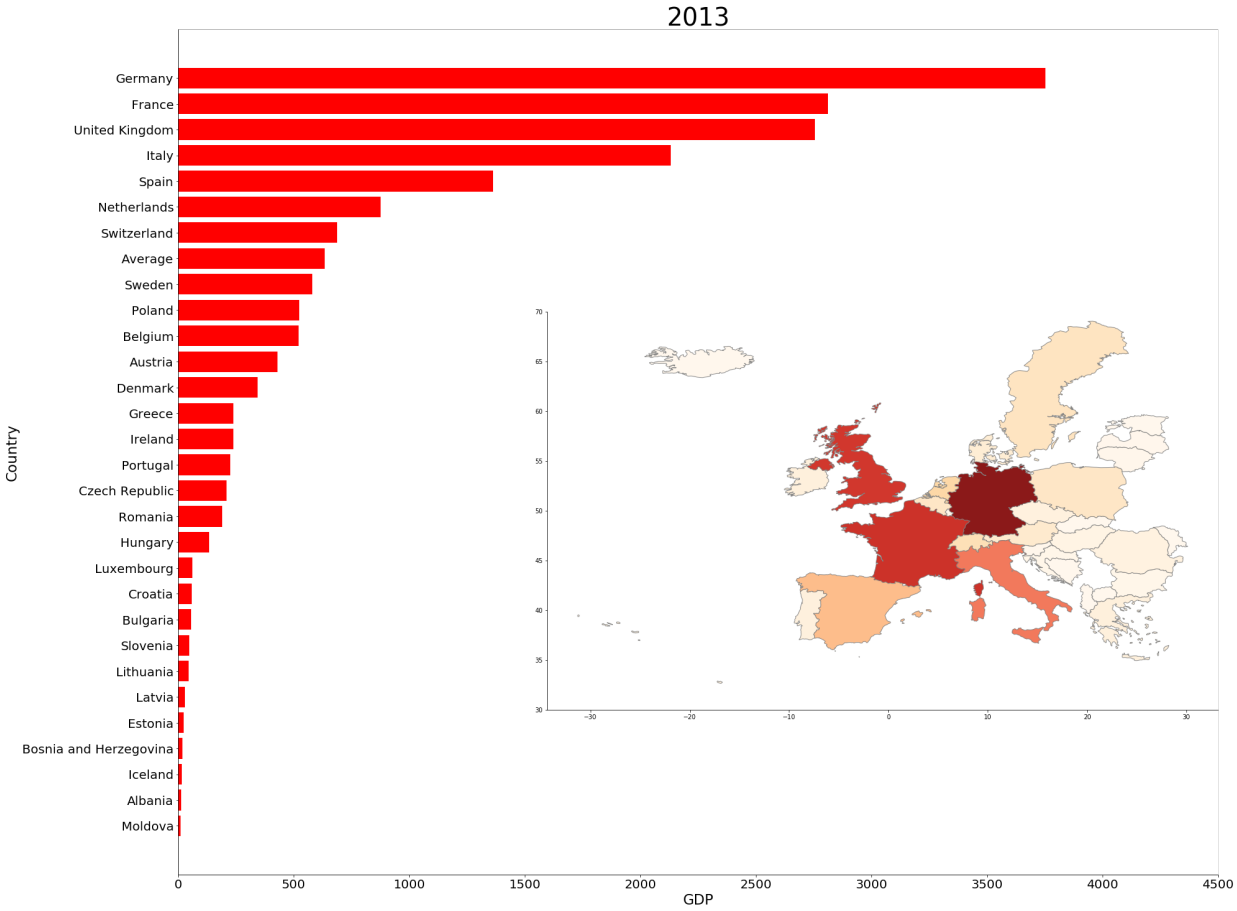
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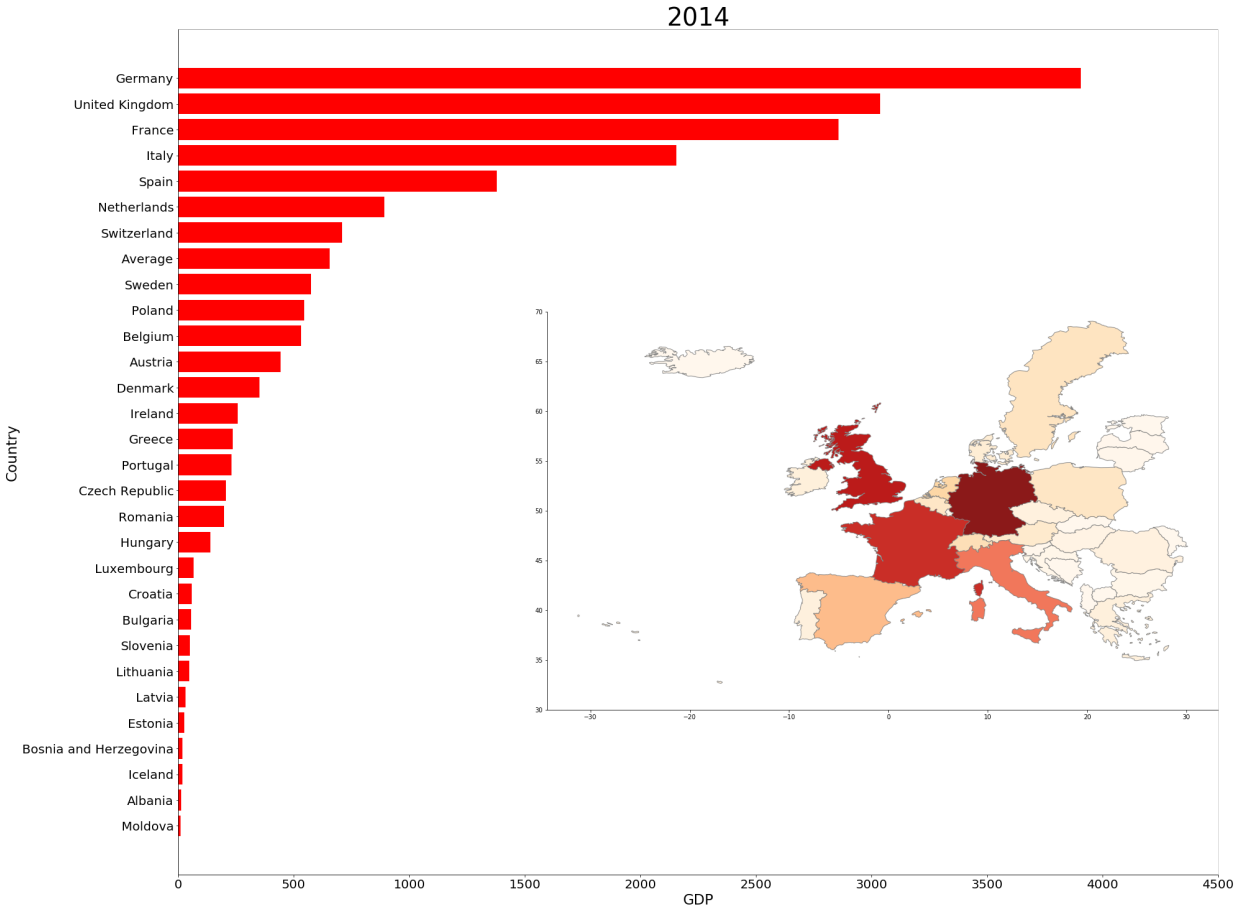
2014
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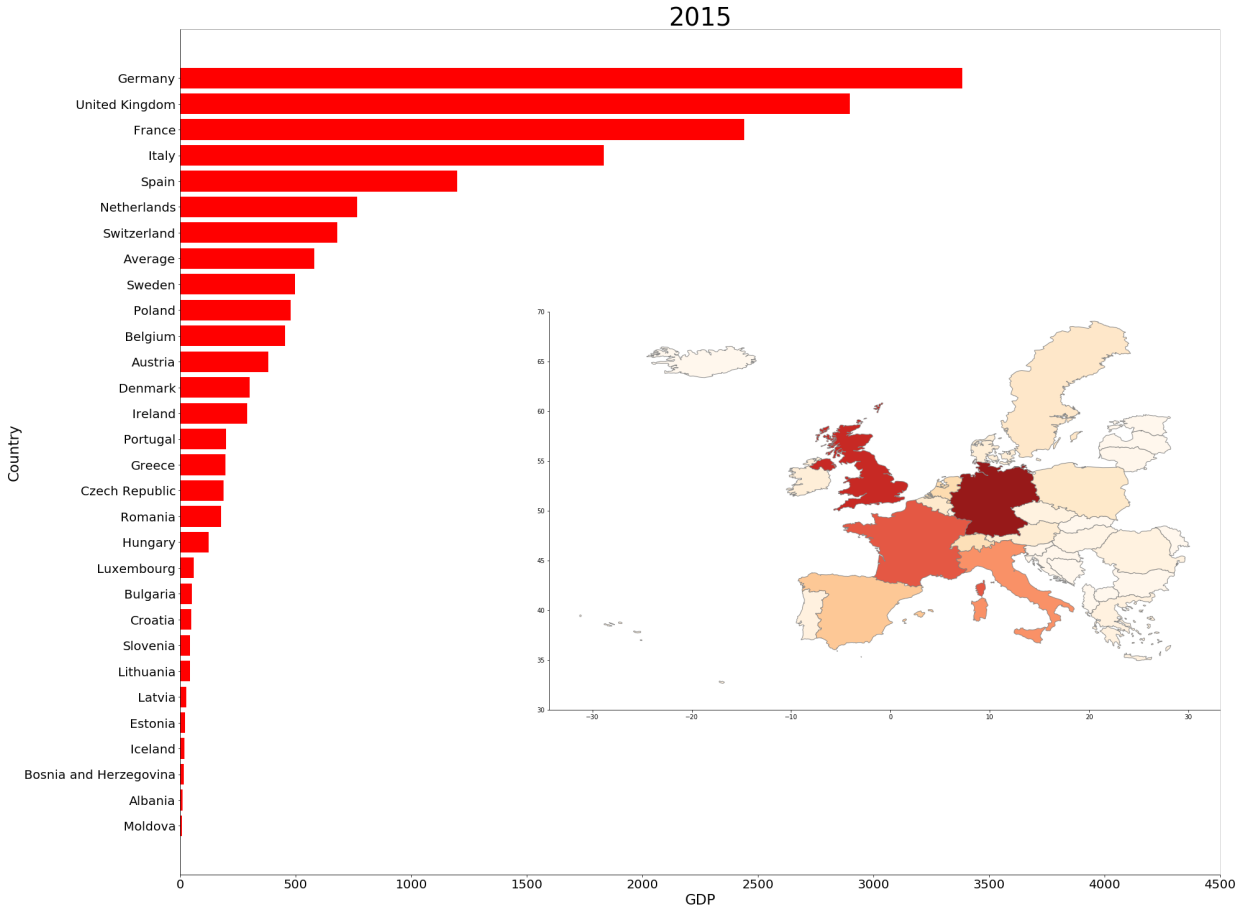
Spain
Netherlands
Switzerland
Average
Sweden
Poland
Belgium
Austria
Denmark
Ireland
Greece
Portugal
Czech Republic
Romania
Hungary
Luxembourg
Croatia
Bulgaria
Slovenia
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0
500
1000
1500
2000
2500
3000
3500
4000
4500
GDP



In [50]:
```
fimages = []
```

In [51]:
```
for filename in year_pic_list:
    fimages.append(imageio.imread(os.getcwd() + "/FinalOutput/" + file
name))
    imageio.mimsave(finaloutputgif, fimages, duration = 1)
```

Now I will look at the natural log of the GDP data and plot that out:

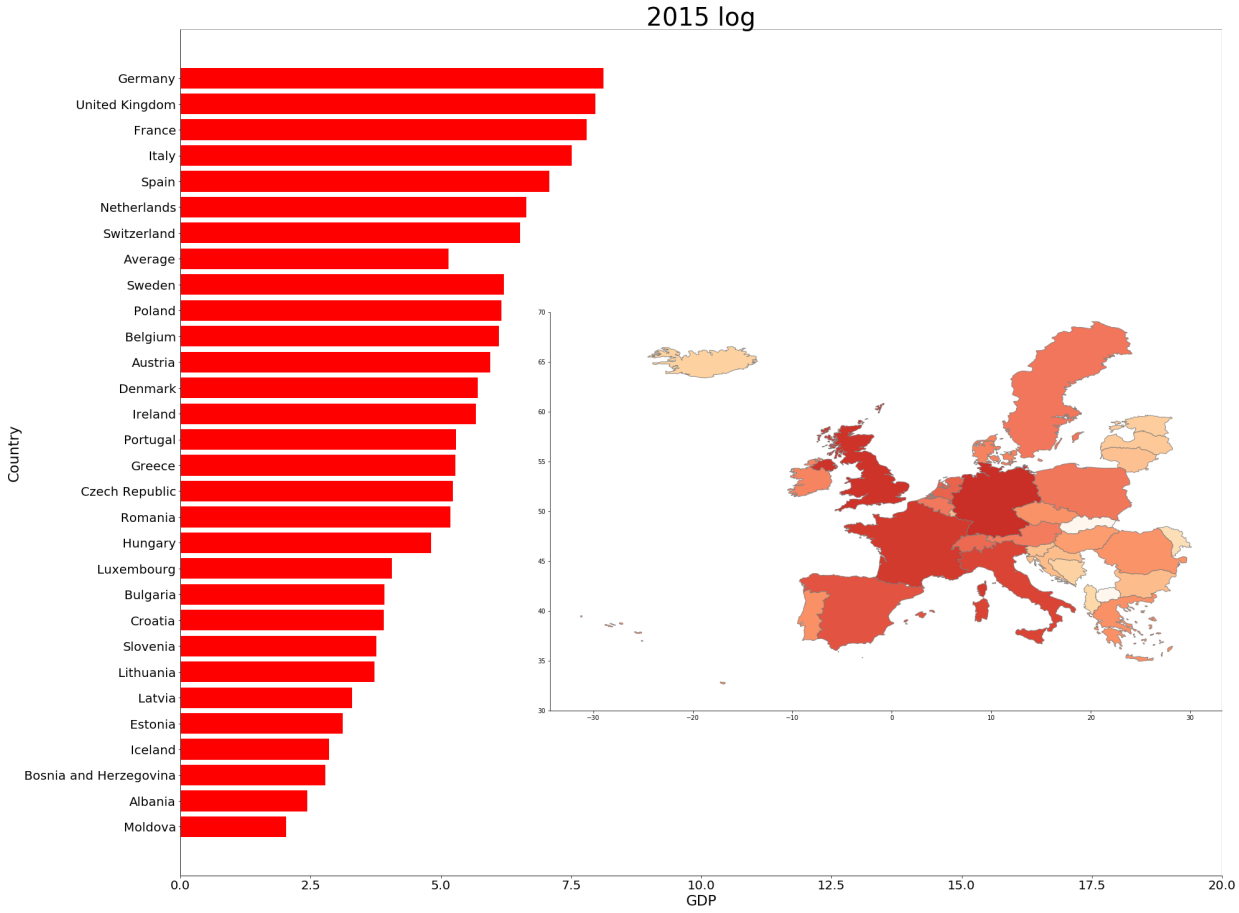
In [52]:
```
year_log_list = []

for year in year_list:
    year_log_list.append(str(year)+" log")
```

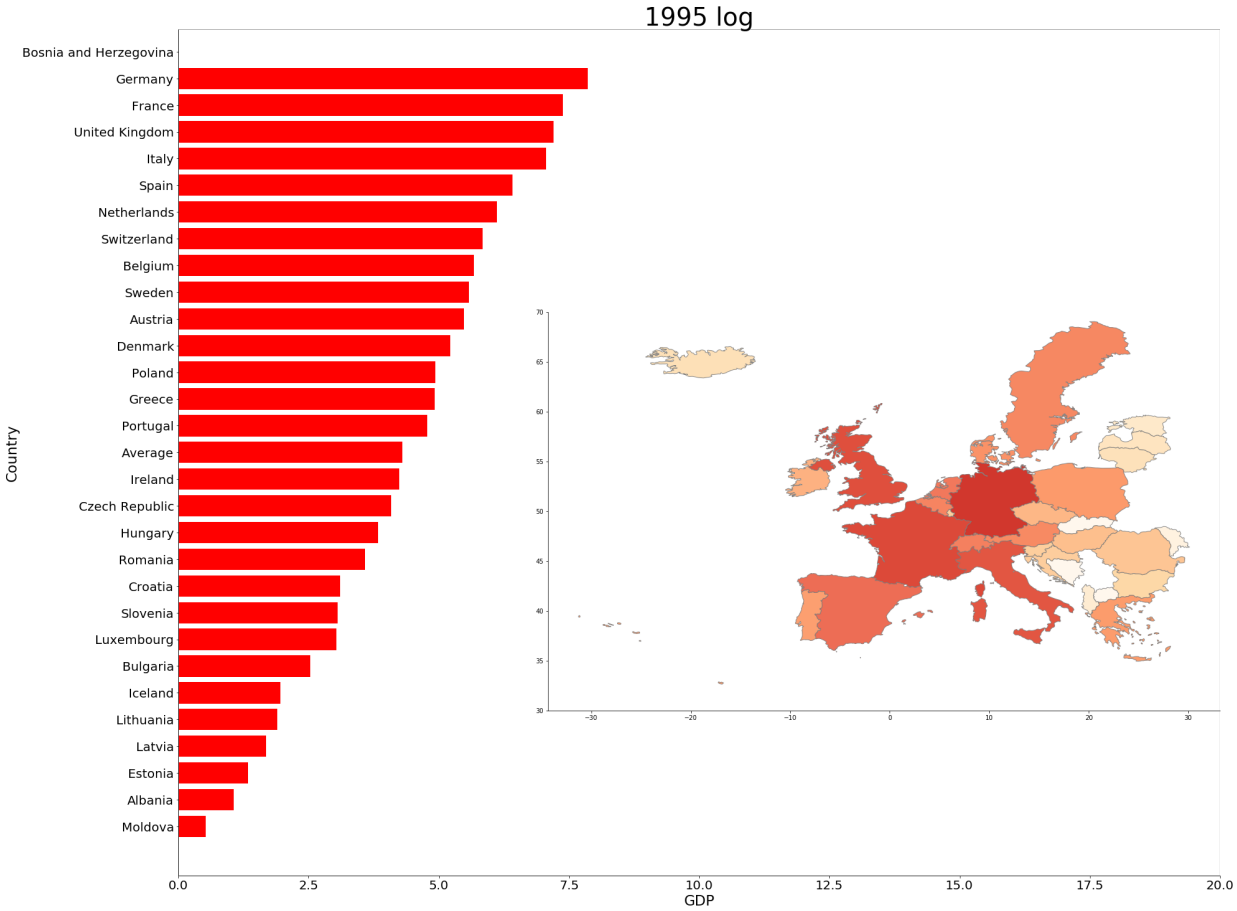
In [53]:
```
year_log_list
```

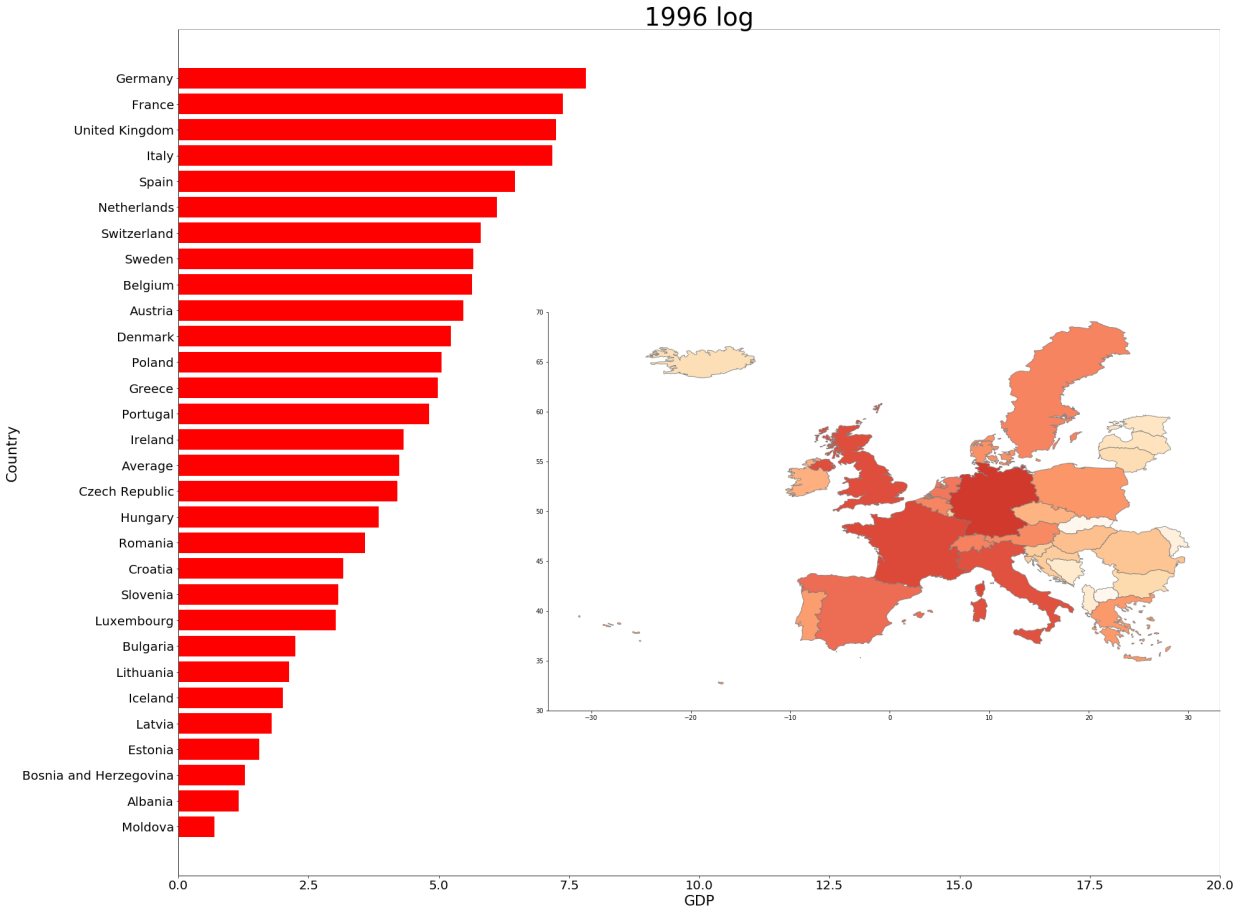
Out[53]:
```
['1995 log',
 '1996 log',
 '1997 log',
 '1998 log',
 '1999 log',
 '2000 log',
 '2001 log',
 '2002 log',
 '2003 log',
 '2004 log',
 '2005 log',
 '2006 log',
 '2007 log',
 '2008 log',
 '2009 log',
 '2010 log',
 '2011 log',
 '2012 log',
 '2013 log',
 '2014 log',
 '2015 log']
```

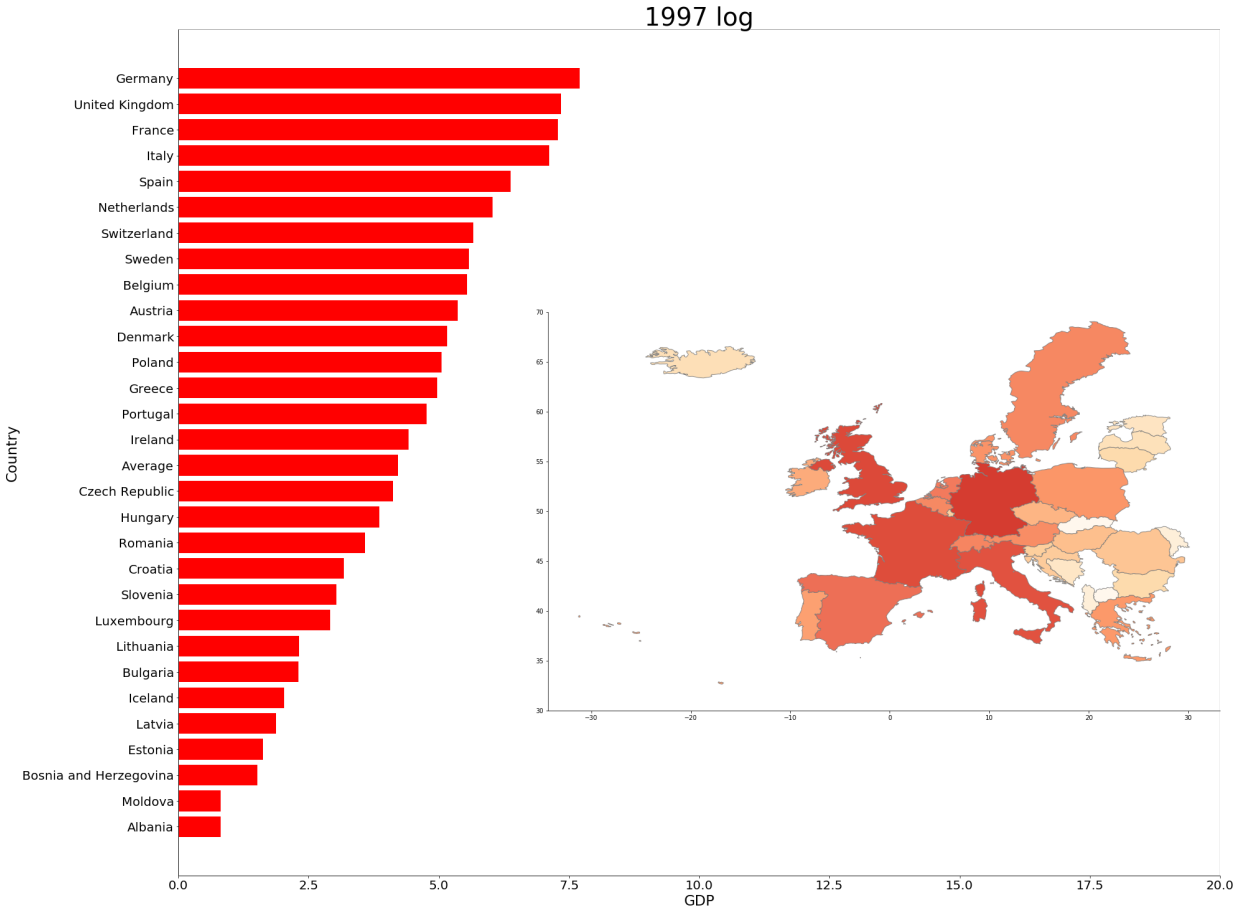
In [54]:
```
final_plot("2015 log", 10,20)
```

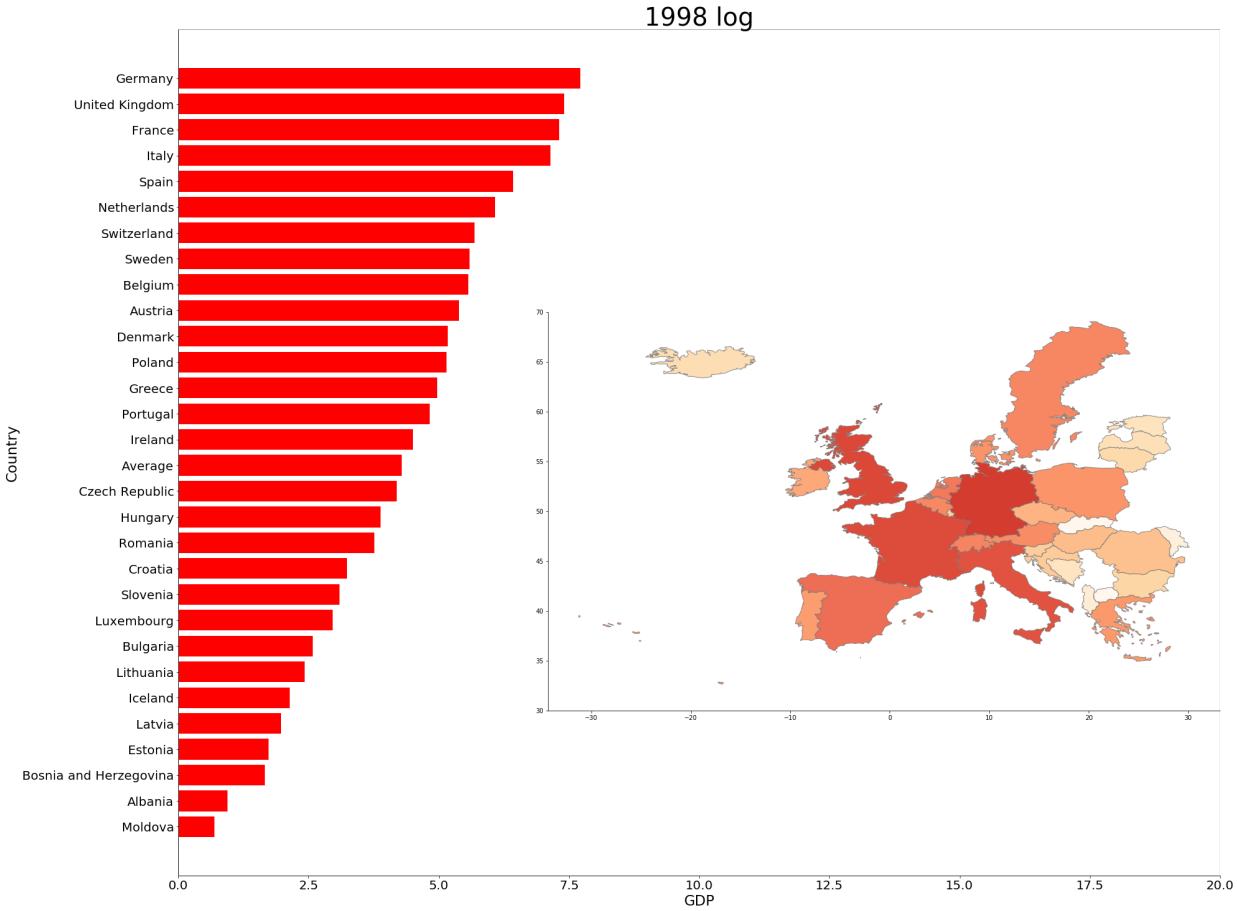


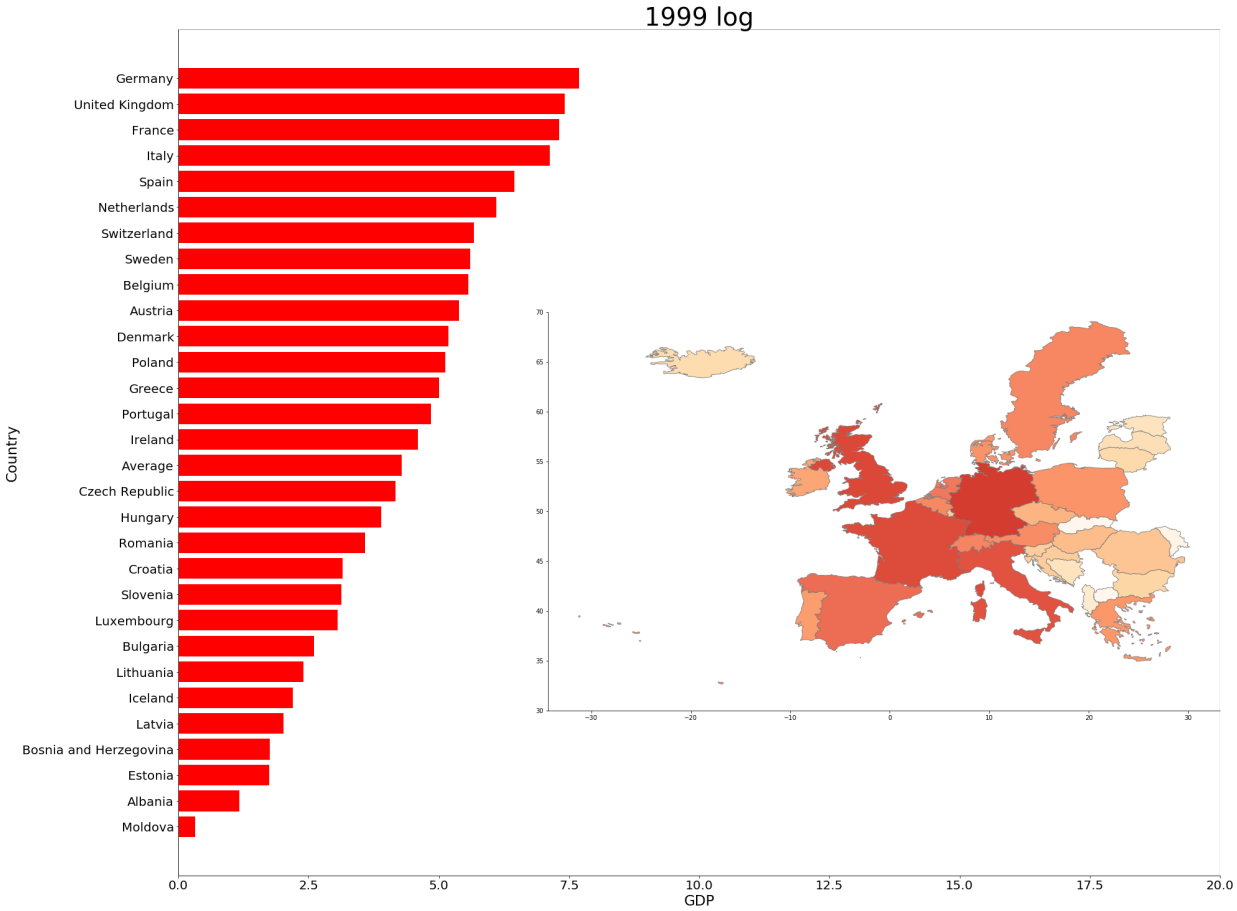
In [55]:
```
for year in year_log_list:
    sort_barchart(year)
    final_plot(year, 10,20)
```

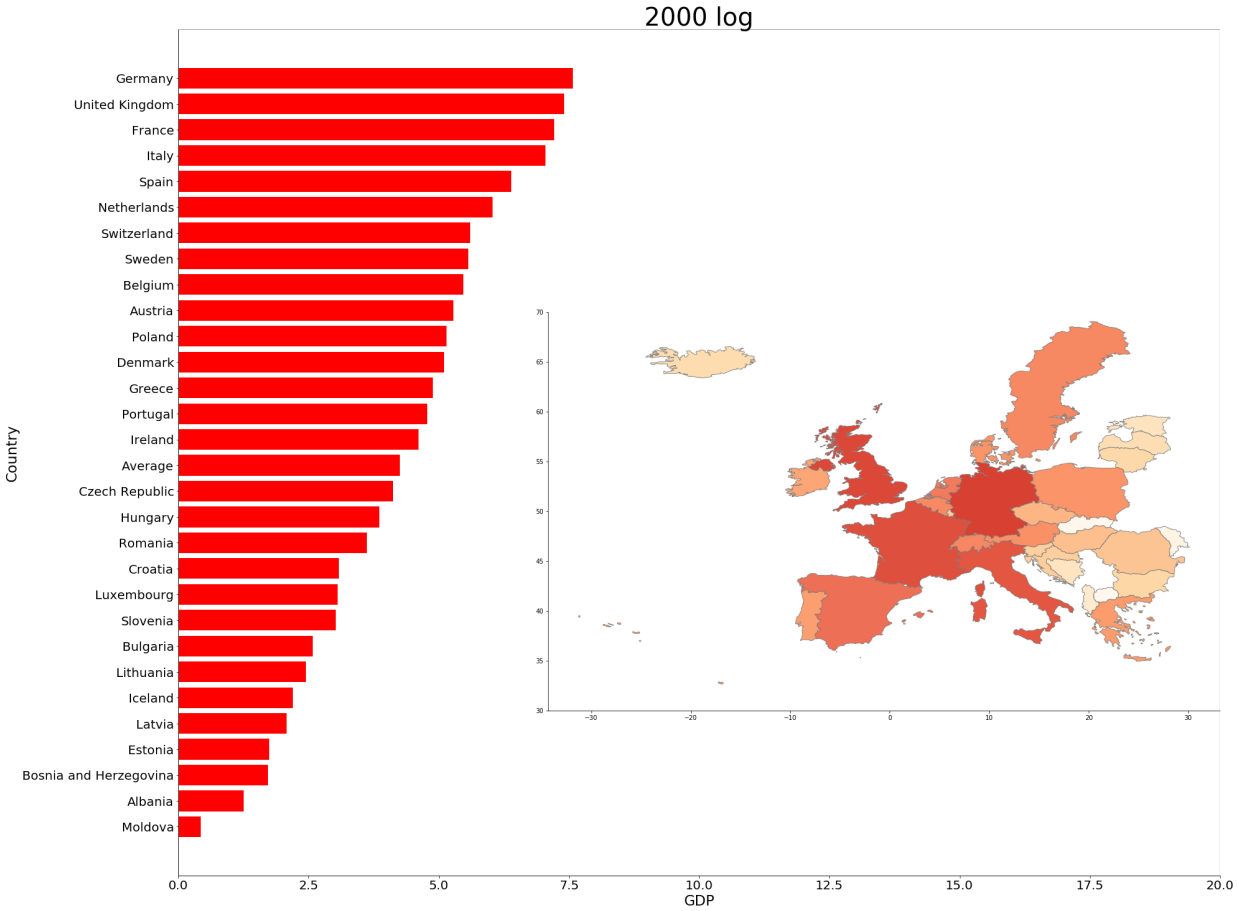

1995 log
Bosnia and Herzegovina
Germany
France
United Kingdom
Italy
Spain
Netherlands
Switzerland
Belgium
Sweden
Austria
Denmark
Poland
Greece
Portugal
Average
Ireland
Czech Republic
Hungary
Romania
Croatia
Slovenia
Luxembourg
Bulgaria
Iceland
Lithuania
Latvia
Estonia
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

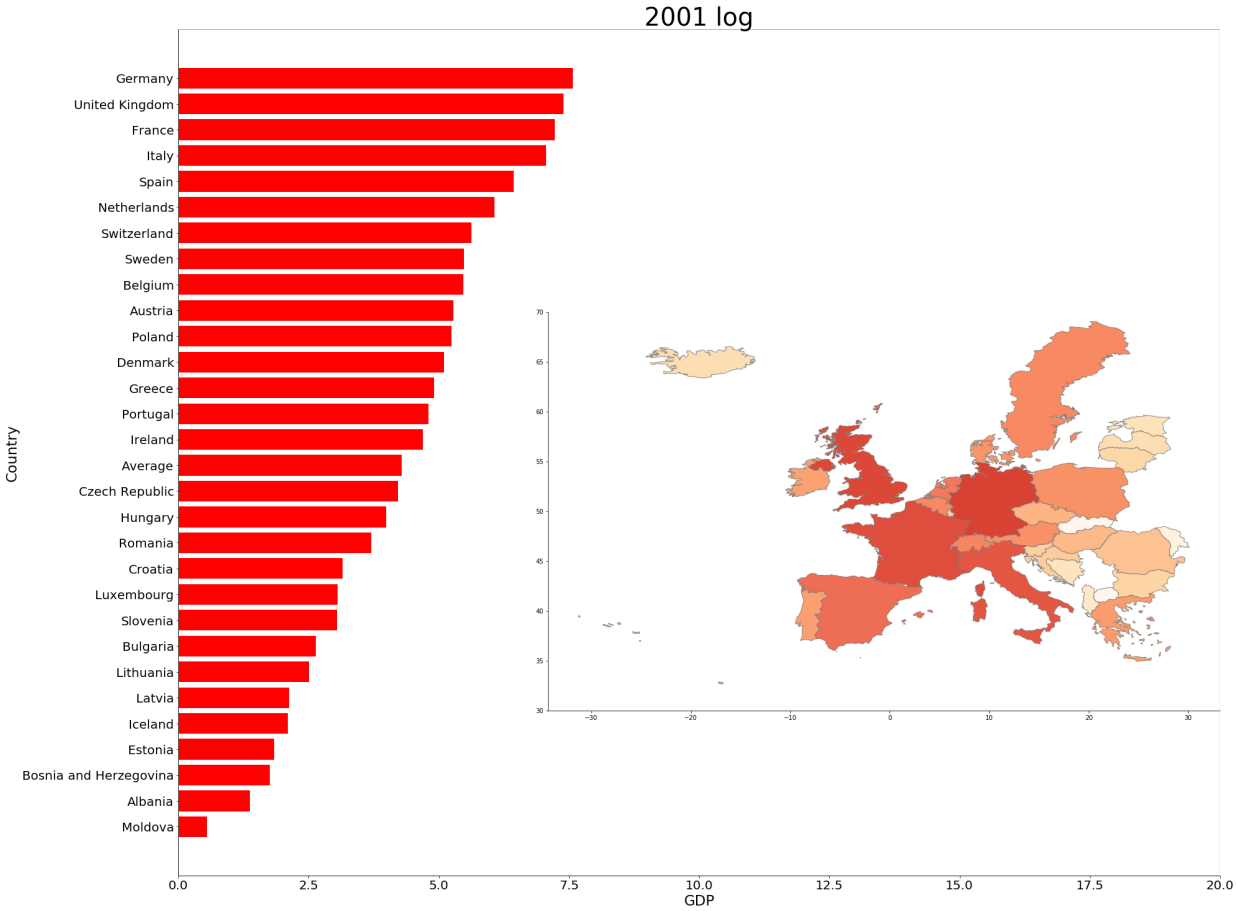

1996 log
Germany
France
United Kingdom
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Denmark
Poland
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Slovenia
Luxembourg
Bulgaria
Lithuania
Iceland
Latvia
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

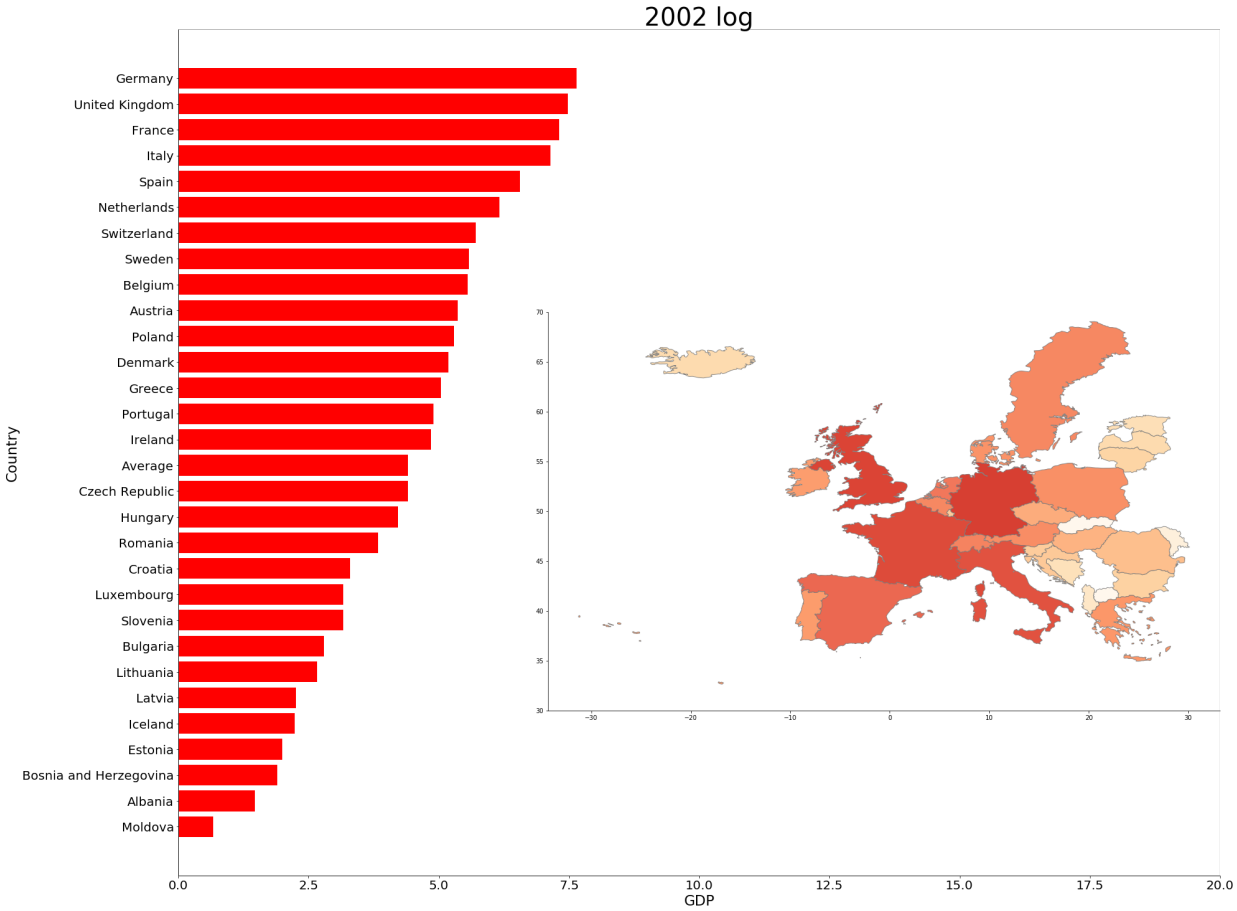

1997 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Denmark
Poland
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Slovenia
Luxembourg
Lithuania
Bulgaria
Iceland
Latvia
Estonia
Bosnia and Herzegovina
Moldova
Albania
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

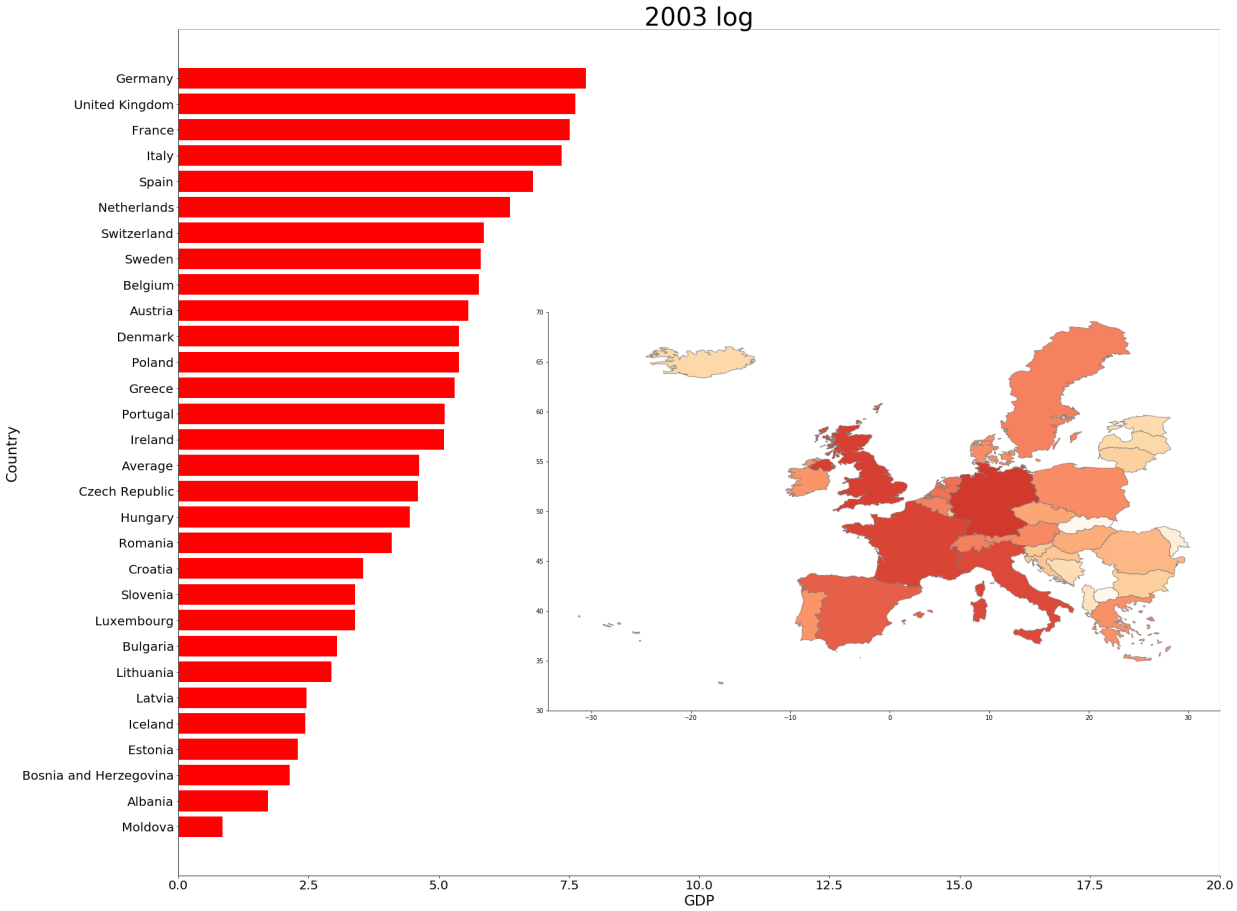

1998 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Denmark
Poland
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Slovenia
Luxembourg
Bulgaria
Lithuania
Iceland
Latvia
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

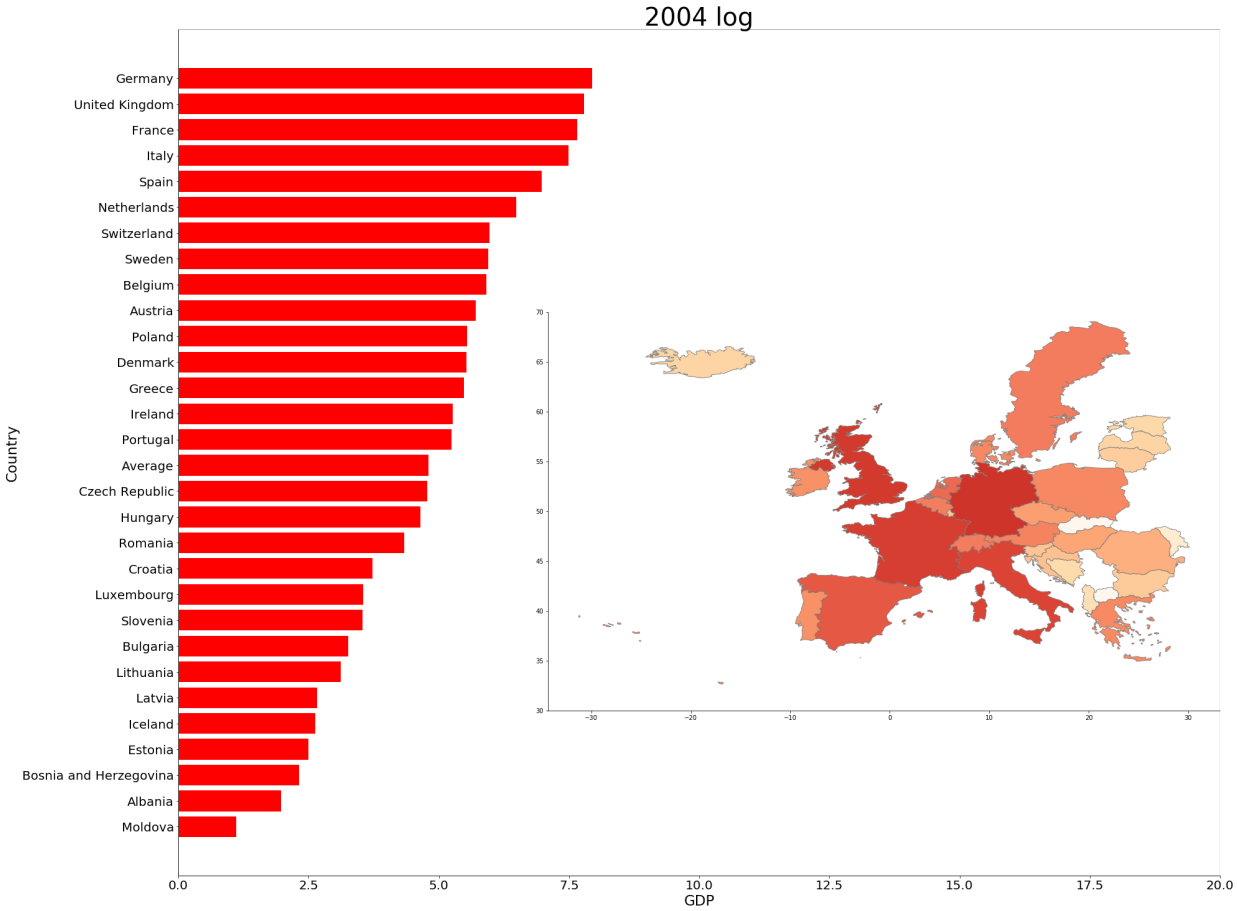

1999 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Denmark
Poland
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Slovenia
Luxembourg
Bulgaria
Lithuania
Iceland
Latvia
Bosnia and Herzegovina
Estonia
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

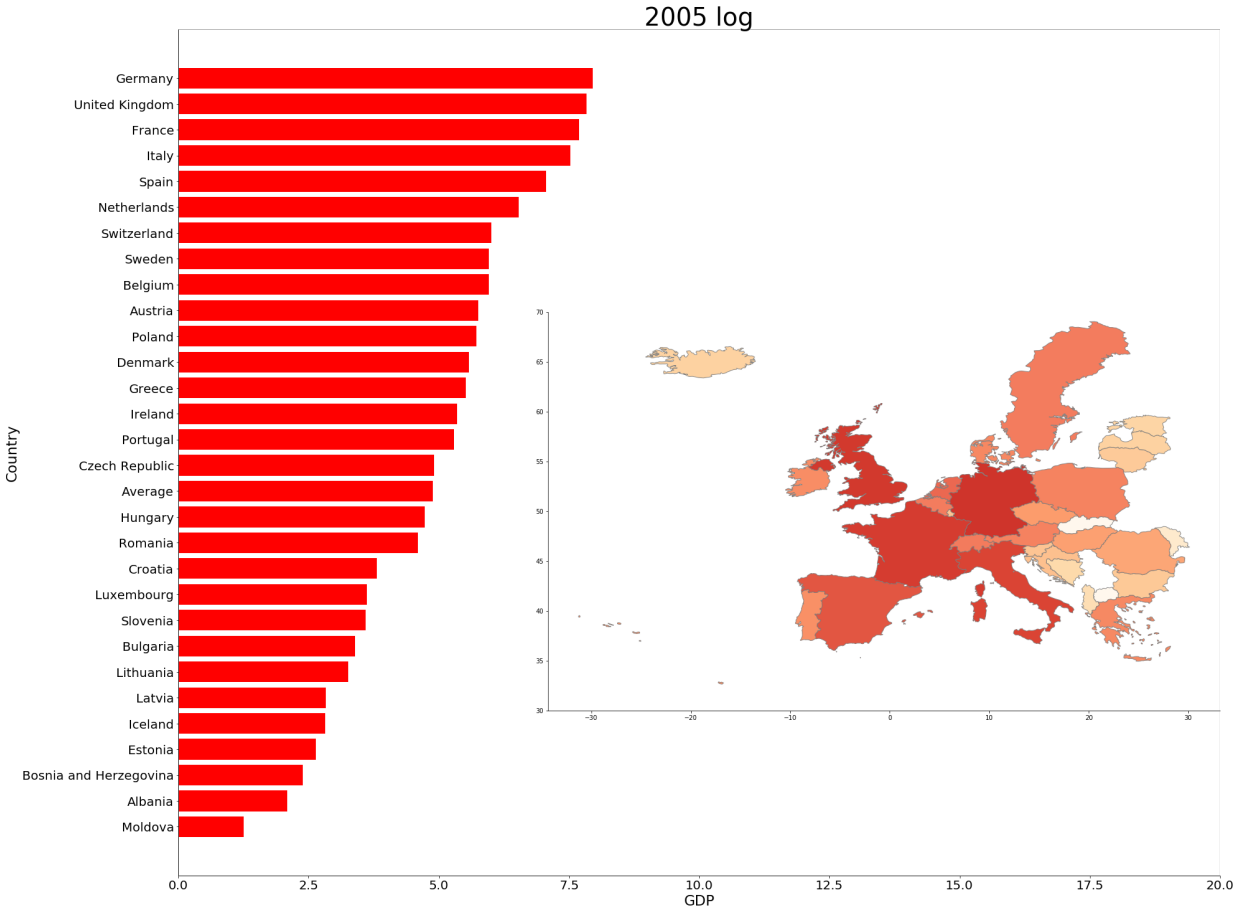

2000 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Poland
Denmark
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Iceland
Latvia
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

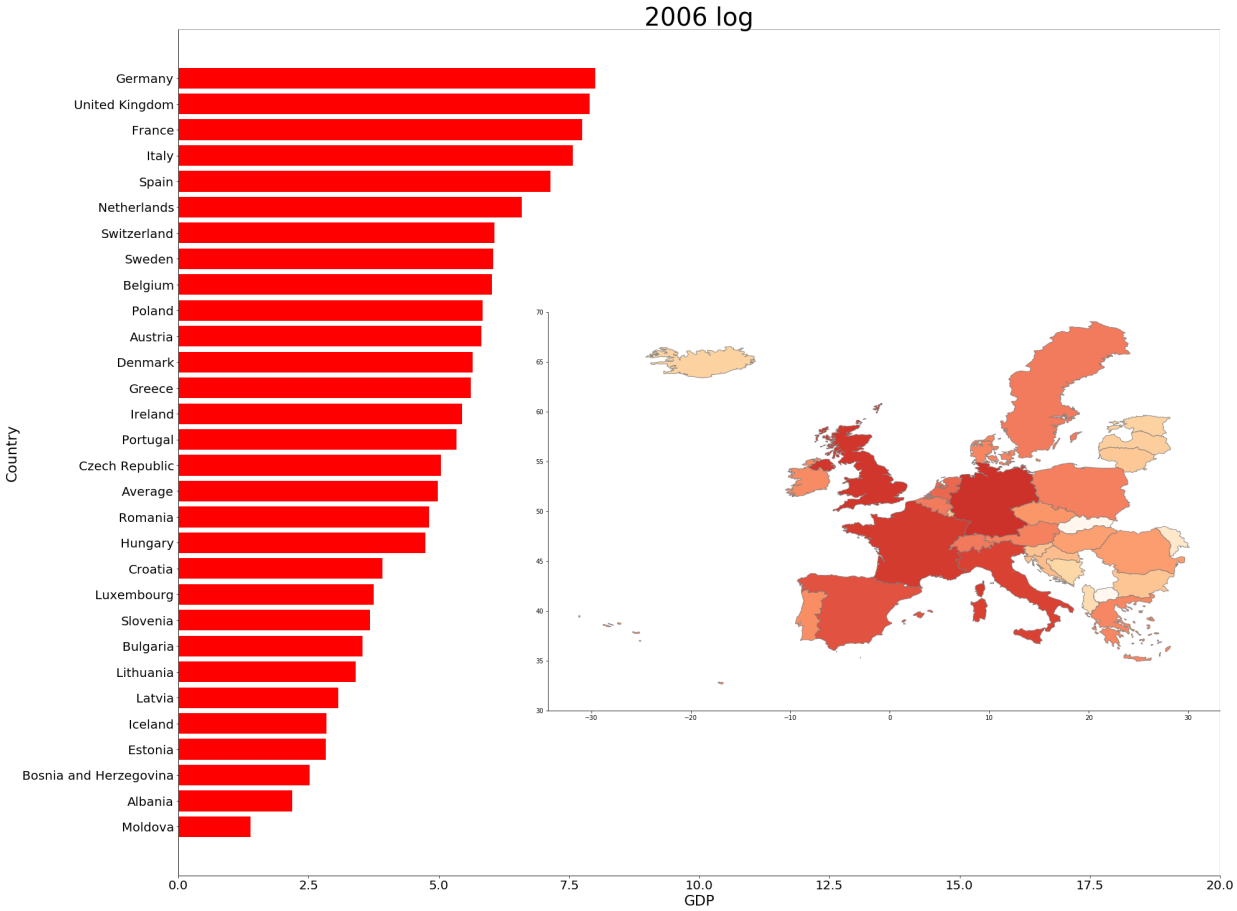

2001 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Poland
Denmark
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Latvia
Iceland
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

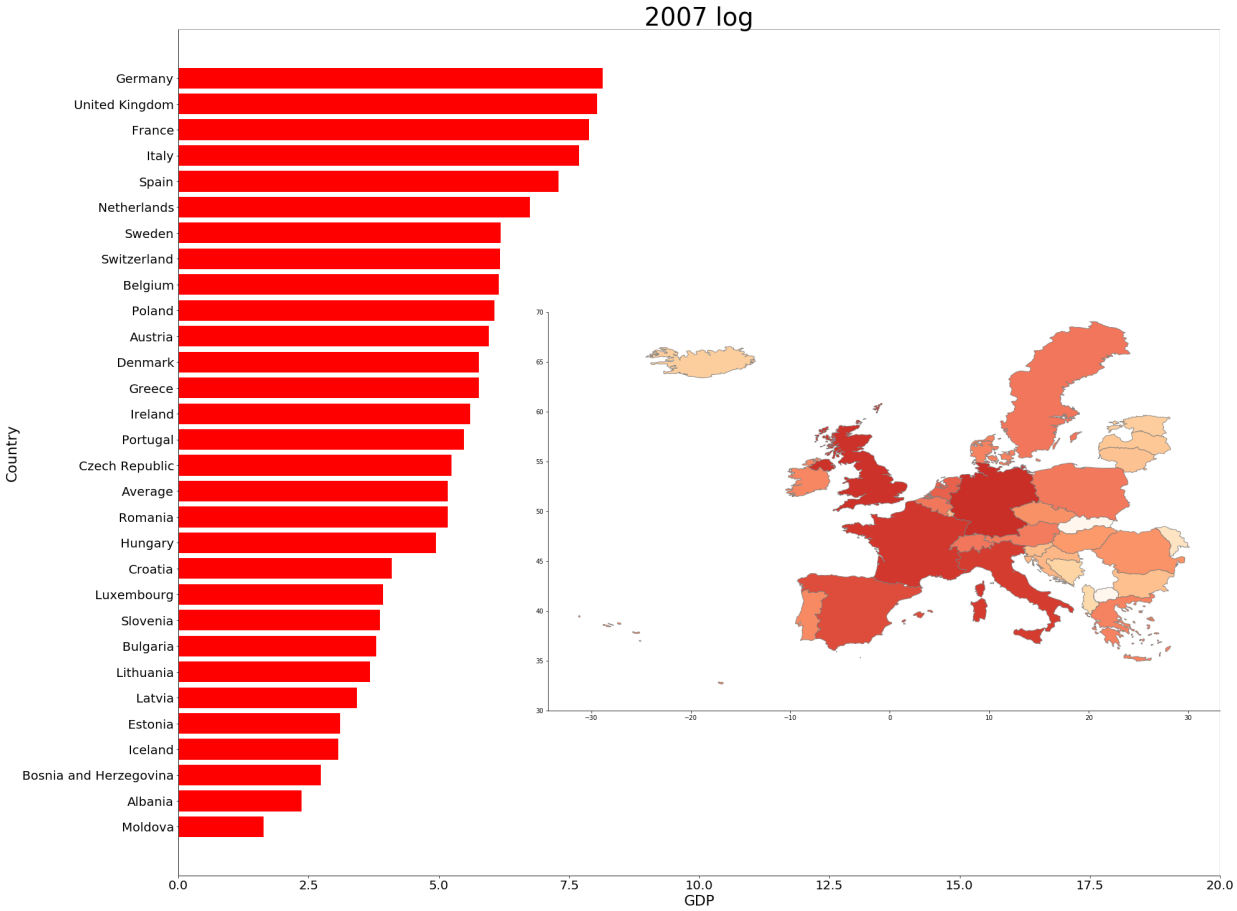

2002 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Poland
Denmark
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Latvia
Iceland
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

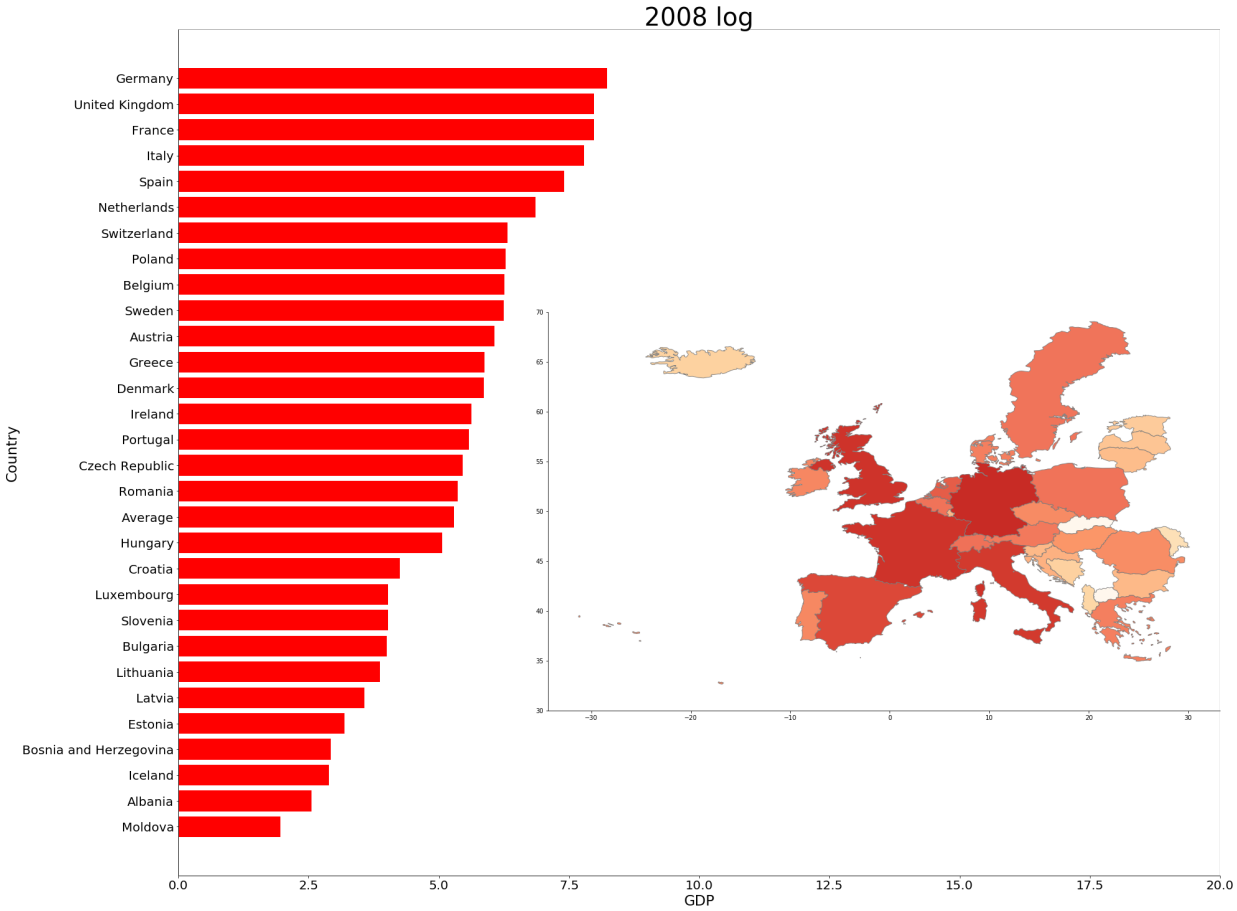

2003 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Denmark
Poland
Greece
Portugal
Ireland
Average
Czech Republic
Hungary
Romania
Croatia
Slovenia
Luxembourg
Bulgaria
Lithuania
Latvia
Iceland
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

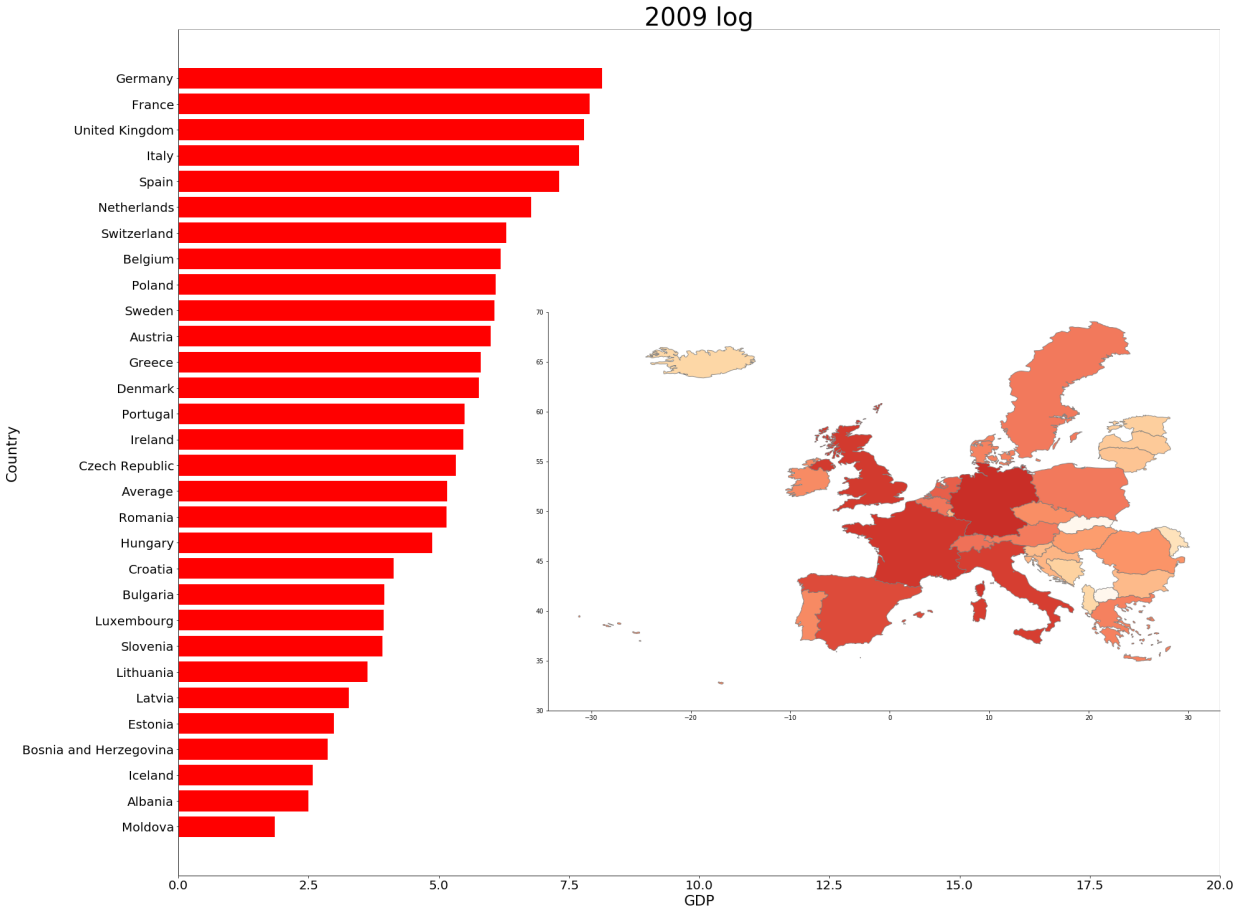

2004 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Poland
Denmark
Greece
Ireland
Portugal
Average
Czech Republic
Hungary
Romania
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Latvia
Iceland
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

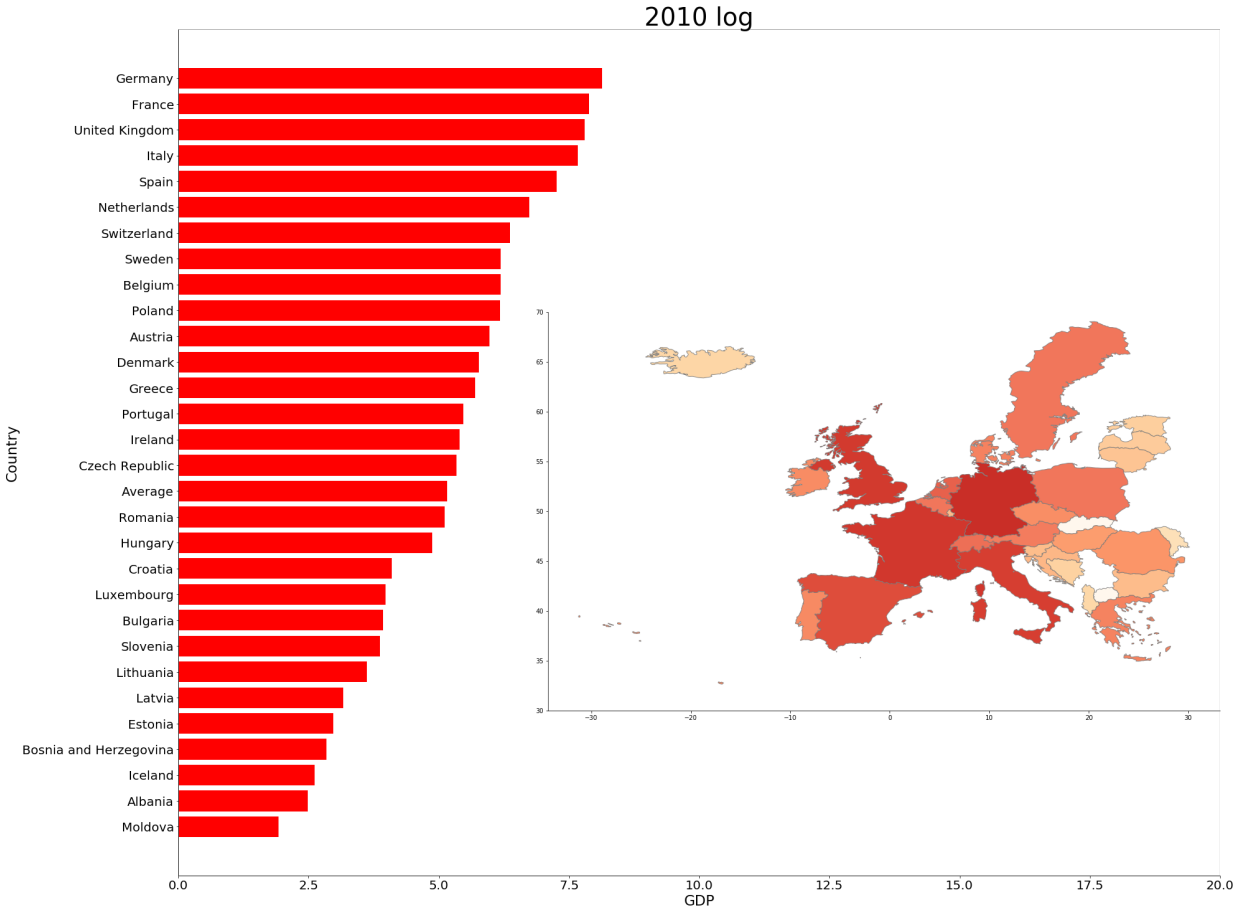

2005 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Austria
Poland
Denmark
Greece
Ireland
Portugal
Czech Republic
Average
Hungary
Romania
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Latvia
Iceland
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

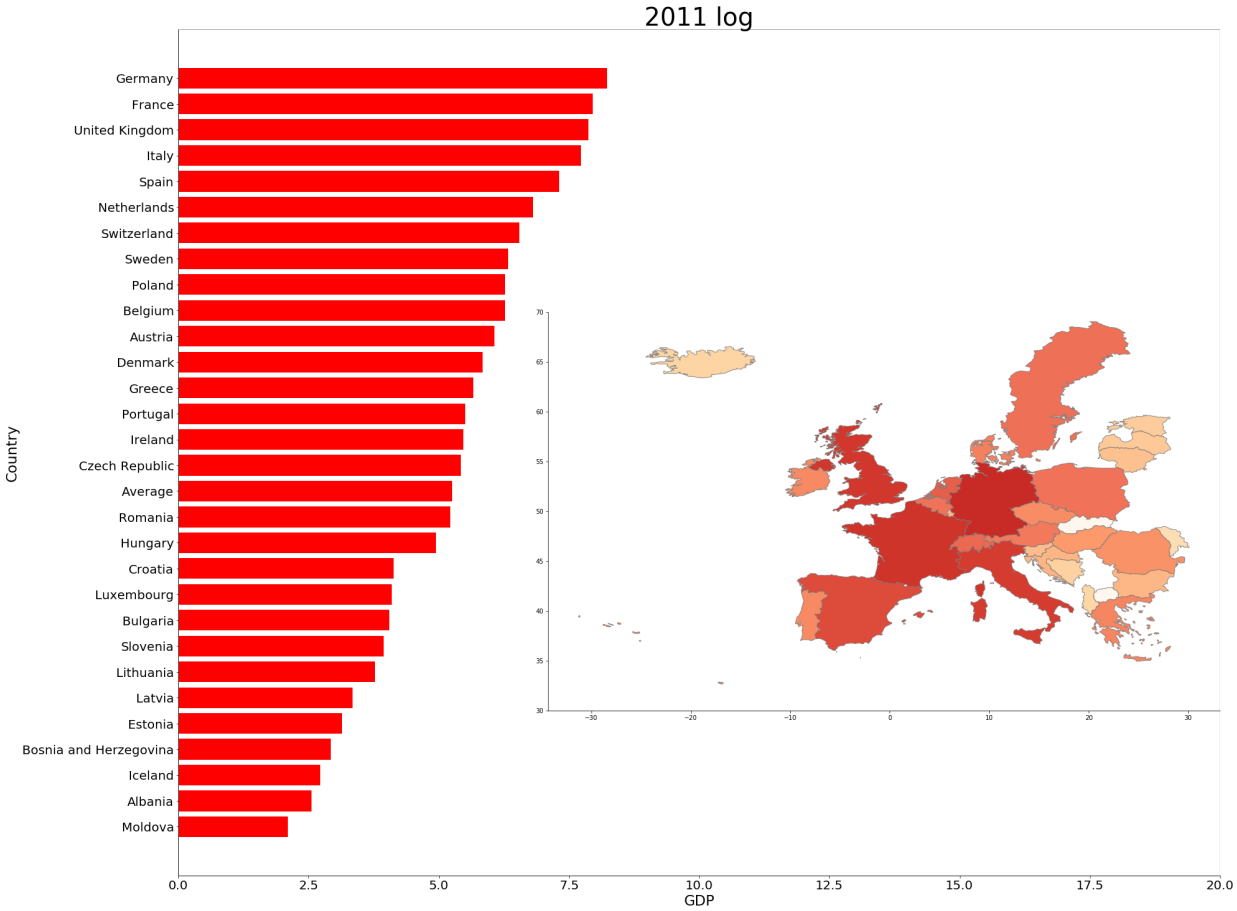

2006 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Poland
Austria
Denmark
Greece
Ireland
Portugal
Czech Republic
Average
Romania
Hungary
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Latvia
Iceland
Estonia
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

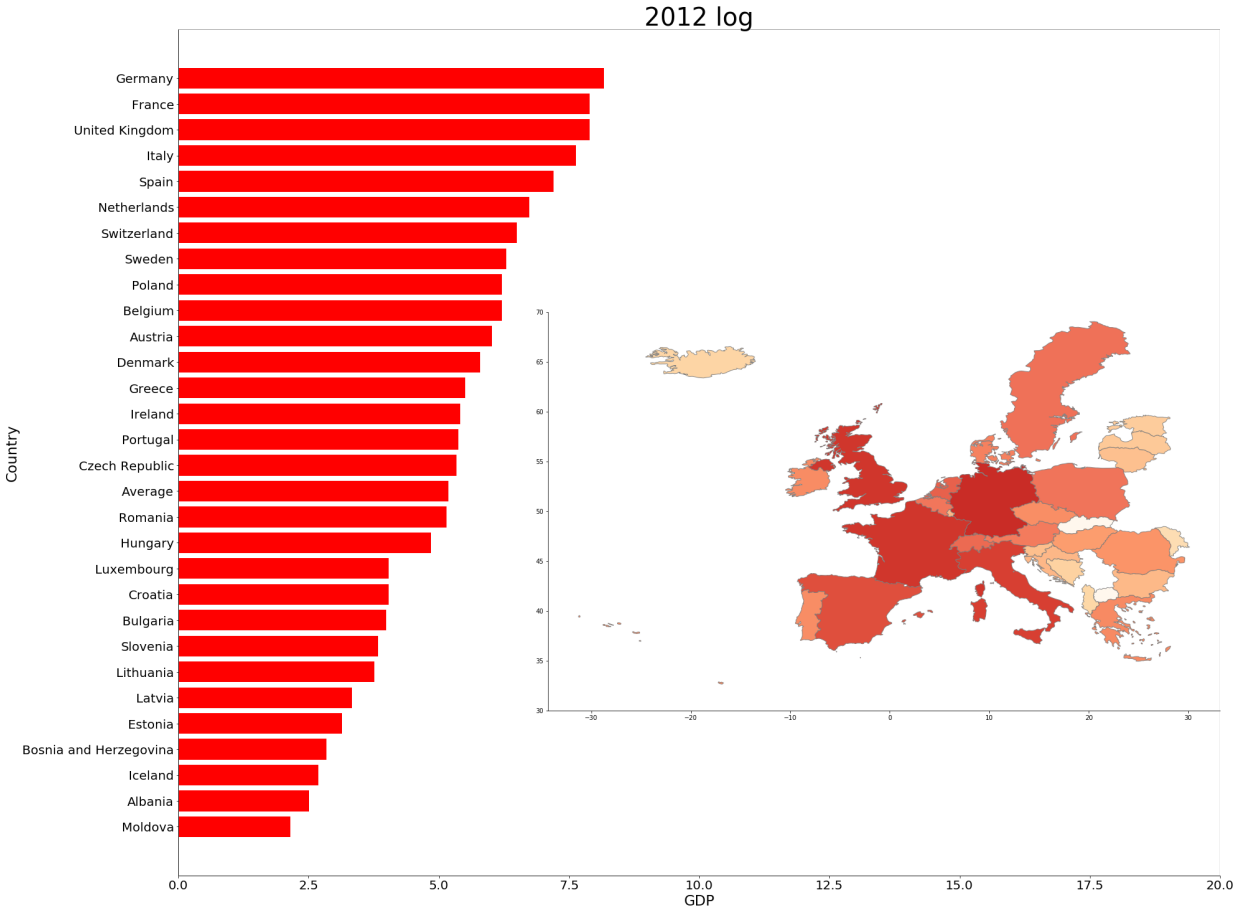

2007 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Sweden
Switzerland
Belgium
Poland
Austria
Denmark
Greece
Ireland
Portugal
Czech Republic
Average
Romania
Hungary
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Latvia
Estonia
Iceland
Bosnia and Herzegovina
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

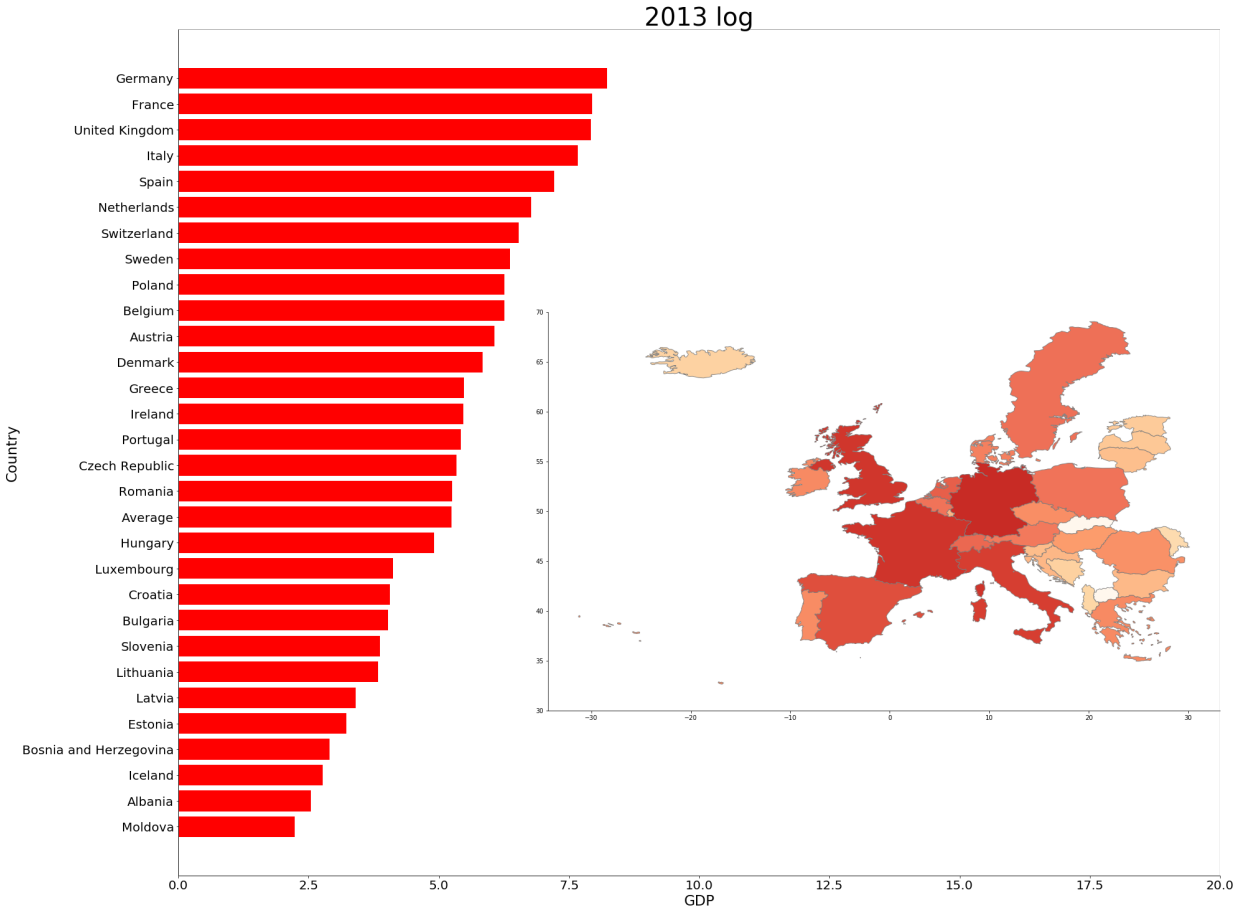

2008 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Poland
Belgium
Sweden
Austria
Greece
Denmark
Ireland
Portugal
Czech Republic
Romania
Average
Hungary
Croatia
Luxembourg
Slovenia
Bulgaria
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

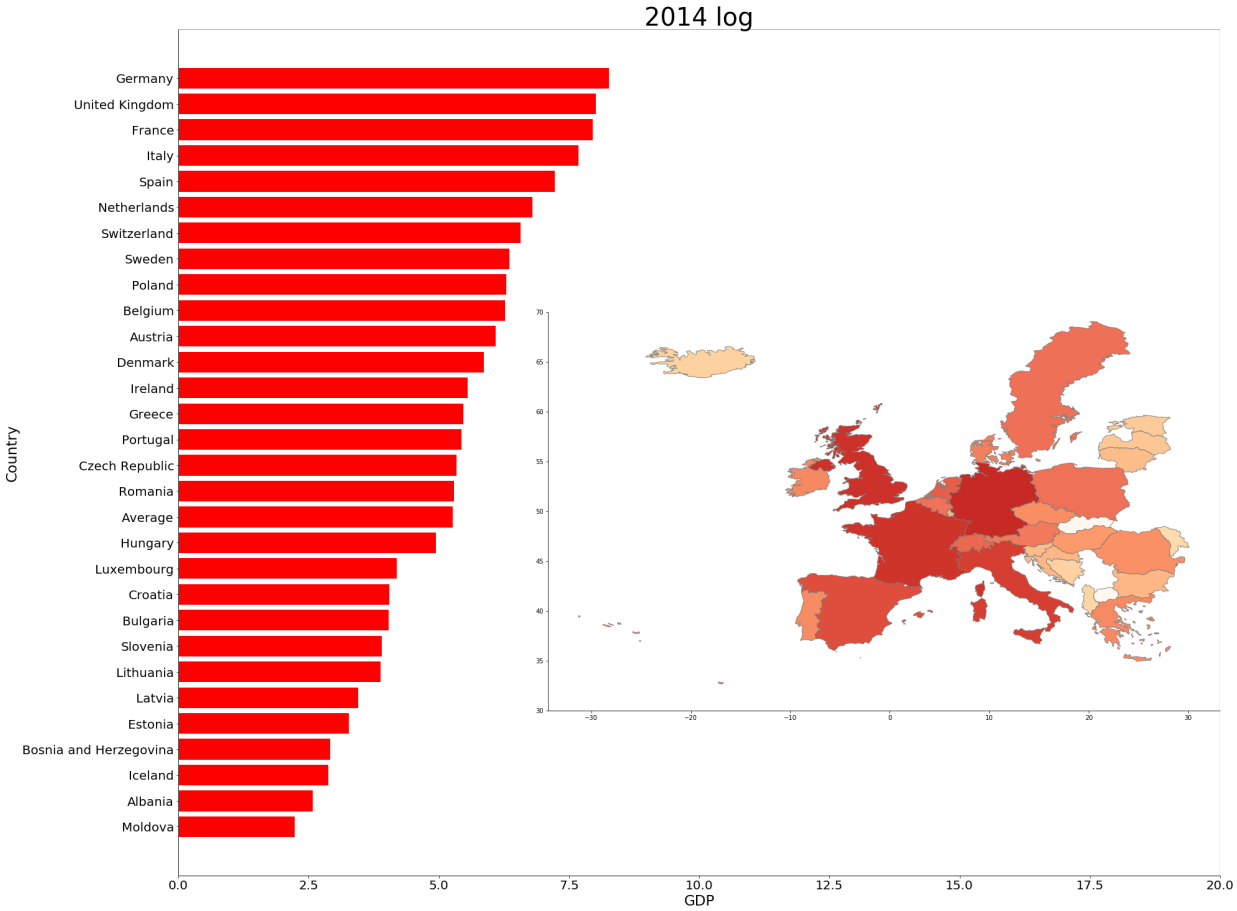

2009 log
Germany
France
United Kingdom
Italy
Spain
Netherlands
Switzerland
Belgium
Poland
Sweden
Austria
Greece
Denmark
Portugal
Ireland
Czech Republic
Average
Romania
Hungary
Croatia
Bulgaria
Luxembourg
Slovenia
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP

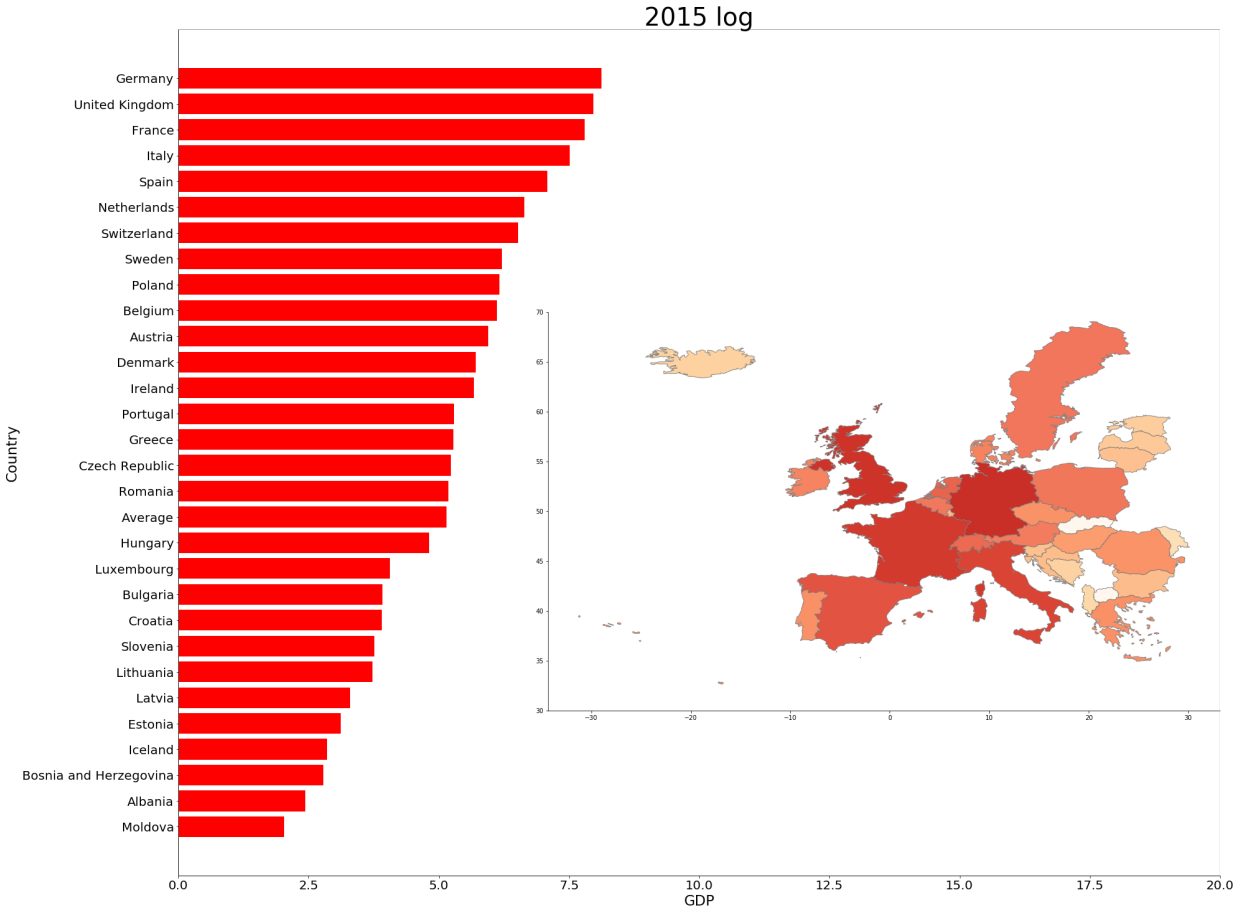

2010 log
Germany
France
United Kingdom
Italy
Spain
Netherlands
Switzerland
Sweden
Belgium
Poland
Austria
Denmark
Greece
Portugal
Ireland
Czech Republic
Average
Romania
Hungary
Croatia
Luxembourg
Bulgaria
Slovenia
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP


2011 log
Germany
France
United Kingdom
Italy
Spain
Netherlands
Switzerland
Sweden
Poland
Belgium
Austria
Denmark
Greece
Portugal
Ireland
Czech Republic
Average
Romania
Hungary
Croatia
Luxembourg
Bulgaria
Slovenia
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP


2012 log
Germany
France
United Kingdom
Italy
Spain
Netherlands
Switzerland
Sweden
Poland
Belgium
Austria
Denmark
Greece
Ireland
Portugal
Czech Republic
Average
Romania
Hungary
Luxembourg
Croatia
Bulgaria
Slovenia
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP


2013 log
Germany
France
United Kingdom
Italy
Spain
Netherlands
Switzerland
Sweden
Poland
Belgium
Austria
Denmark
Greece
Ireland
Portugal
Czech Republic
Romania
Average
Hungary
Luxembourg
Croatia
Bulgaria
Slovenia
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP


2014 log
Germany
United Kingdom
France
Italy
Spain
Netherlands
Switzerland
Sweden
Poland
Belgium
Austria
Denmark
Ireland
Greece
Portugal
Czech Republic
Romania
Average
Hungary
Luxembourg
Croatia
Bulgaria
Slovenia
Lithuania
Latvia
Estonia
Bosnia and Herzegovina
Iceland
Albania
Moldova
Country
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
GDP



In [56]:
```
year_pic_log_list = []

for year in year_log_list:
    year_pic_log_list.append(str(year)+".png")
```

In [85]:
```
logimages = []
```

In [86]:
```
for filename in year_pic_log_list:
    logimages.append(imageio.imread(os.getcwd() + "/FinalOutput/" + fi
lename))
    imageio.mimsave(finaloutputgdplog, logimages, duration = 1)
```

Below, I will read in and clean up the data for GDP per Capita because as I was going through the project

I realized that GDP per Capita might show a better picture of how GDP in Europe changed through the several

economic changes that occured in the area:

In [59]:
```
gdp_per_capita_data = pd.read_excel(per_capita_file_name)
```

In [60]:
```
gdp_per_capita_data
```

Out[60]:

	Country	Subject Descriptor	Units	Scale	Country/Series-specific Notes	1995	1996	1997
0	Afghanistan	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	NaN	NaN	NaN
1	Albania	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	903.989	1009.967	717.381
2	Algeria	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	1499.143	1643.265	1658.732
3	Angola	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	419.529	525.403	599.077
4	Antigua and Barbuda	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	8675.225	9266.488	9678.300
		Gross						

5	Argentina	domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	8053.119	8385.153	8918.826
6	Armenia	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	399.576	503.774	521.869
7	Aruba	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	16546.617	16620.854	17751.072
8	Australia	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	20868.045	23106.852	22990.441
9	Austria	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	30350.546	29820.613	26737.482
10	Azerbaijan	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	316.227	411.140	508.043
11	The Bahamas	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	20271.258	20974.542	21951.765
12	Bahrain	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	12143.091	12298.650	12422.116
13	Bangladesh	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	383.095	393.525	402.894

14	Barbados	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	8414.115	8938.565	9412.367
15	Belarus	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	1000.204	1375.754	1341.854
16	Belgium	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	28610.841	27747.949	25086.126
17	Belize	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	2863.580	2888.603	2845.150
18	Benin	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	370.875	390.360	363.909
19	Bhutan	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	581.144	606.110	668.031
20	Bolivia	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	885.679	955.574	1005.873
21	Bosnia and Herzegovina	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	NaN	947.953	1220.090
22	Botswana	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	2984.191	3006.151	3025.699

23	Brazil	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	4950.659	5200.105	5323.820
24	Brunei Darussalam	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	18292.060	19282.327	19120.874
25	Bulgaria	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	1511.491	1153.869	1228.132
26	Burkina Faso	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	235.832	249.360	229.493
27	Burundi	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	167.177	142.588	157.054
28	Cabo Verde	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	1378.161	1385.771	1322.336
29	Cambodia	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	319.537	316.188	302.166
...	...	...	...	...	...	...	...	...
166	Sweden	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	29911.820	32614.252	29932.755
		Gross domestic product	U.S.		See notes for: Gross domestic			

167	Switzerland	per capita, current prices	dollars	Units	product, curren...	48833.742	46764.510	40469.550
168	Syria	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	1133.162	1186.162	1080.812
169	Taiwan Province of China	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	13076.007	13597.248	13968.097
170	Tajikistan	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	100.448	183.374	192.580
171	Tanzania	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	147.749	179.540	211.070
172	Thailand	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	2871.564	3071.062	2492.616
173	Timor-Leste	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	NaN	NaN	NaN
174	Togo	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	406.548	431.283	425.029
175	Tonga	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	2199.634	2410.489	2254.233
		Gross						

176	Trinidad and Tobago	domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	4319.496	4655.849	4629.726
177	Tunisia	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	2156.454	2299.375	2210.809
178	Turkey	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	3877.104	4095.582	4220.595
179	Turkmenistan	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	1394.427	554.283	614.767
180	Tuvalu	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	NaN	NaN	NaN
181	Uganda	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	309.747	309.377	326.722
182	Ukraine	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	752.339	914.348	1037.893
183	United Arab Emirates	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	26394.423	29058.859	29523.485
184	United Kingdom	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	23026.709	24256.456	26647.953

185	United States	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	28671.480	29946.973	31440.087
186	Uruguay	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	6601.537	6974.809	7295.989
187	Uzbekistan	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	448.126	601.909	616.106
188	Vanuatu	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	1479.565	1511.705	1537.620
189	Venezuela	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	3559.770	3174.631	3777.785
190	Vietnam	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	288.874	337.524	361.908
191	Yemen	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	840.832	411.266	418.526
192	Zambia	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	410.542	378.710	440.701
193	Zimbabwe	Gross domestic product per capita, current prices	U.S. dollars	Units	See notes for: Gross domestic product, curren...	717.092	849.876	881.223

194	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
195	International Monetary Fund, World Economic Ou...	NaN	NaN	NaN	NaN	NaN	NaN	NaN

196 rows × 27 columns

In [61]:
```
gdp_per_capita_data = gdp_per_capita_data.drop(["Subject Descriptor","
Units","Scale","Country/Series-specific Notes"], axis=1)
```

In [62]:
```
gdp_per_capita_data = gdp_per_capita_data.set_index("Country")
```

In [63]:
```
gdp_per_capita_data
```

Out[63]:

Country	1995	1996	1997	1998	1999	2000	2001	
Afghanistan	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
Albania	903.989	1009.967	717.381	818.320	1032.264	1127.640	1283.573	
Algeria	1499.143	1643.265	1658.732	1633.090	1630.071	1794.695	1768.577	
Angola	419.529	525.403	599.077	493.041	452.677	652.110	619.697	
Antigua and Barbuda	8675.225	9266.488	9678.300	10074.768	10349.505	10981.376	10414.643	1(
Argentina	8053.119	8385.153	8918.826	9005.377	8452.876	8386.587	7851.658	2
Armenia	399.576	503.774	521.869	608.415	597.241	620.638	692.287	
Aruba	16546.617	16620.854	17751.072	18825.012	19215.013	20678.398	20909.299	2
Australia	20868.045	23106.852	22990.441	20346.819	21726.343	20851.865	19431.456	2
Austria	30350.546	29820.613	26737.482	27399.085	27209.314	24631.577	24554.252	2(
Azerbaijan	316.227	411.140	508.043	543.344	576.005	656.386	674.783	
The Bahamas	20271.258	20974.542	21951.765	23300.808	25780.484	26669.443	27060.515	2(
Bahrain	12143.091	12298.650	12422.116	11565.971	12210.221	14214.580	13894.343	1
Bangladesh	383.095	393.525	402.894	407.350	415.371	412.334	406.410	
Barbados	8414.115	8938.565	9412.367	10573.109	11039.097	11337.027	11284.369	1

Belarus	1000.204	1375.754	1341.854	1452.410	1165.601	1277.052	1247.469	
Belgium	28610.841	27747.949	25086.126	25602.963	25508.413	23298.473	23189.549	25
Belize	2863.580	2888.603	2845.150	2888.405	3013.080	3330.955	3388.367	3
Benin	370.875	390.360	363.909	380.166	404.155	375.215	378.979	
Bhutan	581.144	606.110	668.031	715.848	730.512	773.491	783.204	
Bolivia	885.679	955.574	1005.873	1057.720	1010.580	1005.409	959.844	
Bosnia and Herzegovina	NaN	947.953	1220.090	1408.122	1533.908	1474.450	1533.616	
Botswana	2984.191	3006.151	3025.699	2841.934	3173.687	3301.212	3090.261	3
Brazil	4950.659	5200.105	5323.820	5128.338	3502.751	3771.940	3177.826	2
Brunei Darussalam	18292.060	19282.327	19120.874	14526.109	16112.075	20511.076	18680.432	18
Bulgaria	1511.491	1153.869	1228.132	1631.940	1673.660	1613.935	1783.719	2
Burkina Faso	235.832	249.360	229.493	255.718	267.017	226.844	237.449	
Burundi	167.177	142.588	157.054	141.755	133.412	130.225	127.349	
Cabo Verde	1378.161	1385.771	1322.336	1376.757	1529.878	1354.544	1387.167	
Cambodia	319.537	316.188	302.166	267.864	293.699	299.982	320.046	
...	...	...	...	...	...	...	...	
Sweden	29911.820	32614.252	29932.755	30180.212	30601.857	29287.801	26970.431	29
Switzerland	48833.742	46764.510	40469.550	41547.909	40642.238	37993.795	38715.763	47
Syria	1133.162	1186.162	1080.812	1028.169	1043.174	1202.891	1236.897	
Taiwan Province of China	13076.007	13597.248	13968.097	12787.258	13768.274	14876.879	13408.383	13
Tajikistan	100.448	183.374	192.580	222.282	177.712	159.417	167.035	
Tanzania	147.749	179.540	211.070	303.010	363.109	378.494	378.881	
Thailand	2871.564	3071.062	2492.616	1866.597	2057.318	2030.725	1921.673	2
Timor-Leste	NaN	NaN	NaN	NaN	NaN	489.866	569.609	
Togo	406.548	431.283	425.029	388.934	377.803	311.499	300.953	
Tonga	2199.634	2410.489	2254.233	2012.456	2035.946	1965.571	1775.167	
Trinidad and Tobago	4319.496	4655.849	4629.726	4869.365	5475.183	6541.694	7042.209	7
Tunisia	2156.454	2299.375	2210.809	2295.188	2388.986	2213.949	2254.913	2
Turkey	3877.104	4095.582	4220.595	4387.308	4019.001	4218.859	3053.282	3

Turkmenistan	1394.427	554.283	614.767	647.355	861.861	1109.216	1514.431	
Tuvalu	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
Uganda	309.747	309.377	326.722	310.180	285.563	273.964	268.065	
Ukraine	752.339	914.348	1037.893	874.265	664.990	664.376	784.864	
United Arab Emirates	26394.423	29058.859	29523.485	25897.653	27321.043	34688.979	32621.292	3
United Kingdom	23026.709	24256.456	26647.953	28077.336	28435.056	28043.874	27510.331	2
United States	28671.480	29946.973	31440.087	32833.666	34494.539	36317.741	37101.103	3
Uruguay	6601.537	6974.809	7295.989	7667.105	7193.466	6817.363	6238.214	
Uzbekistan	448.126	601.909	616.106	616.901	693.220	560.173	468.772	
Vanuatu	1479.565	1511.705	1537.620	1441.112	1435.664	1422.228	1317.091	
Venezuela	3559.770	3174.631	3777.785	3973.415	4121.578	4823.961	4965.408	
Vietnam	288.874	337.524	361.908	360.925	374.722	401.567	413.342	
Yemen	840.832	411.266	418.526	374.911	439.292	539.641	532.421	
Zambia	410.542	378.710	440.701	352.627	330.283	340.164	376.986	
Zimbabwe	717.092	849.876	881.223	1029.202	1003.834	969.824	964.080	
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
International Monetary Fund, World Economic Outlook Database, April 2019	NaN	NaN	NaN	NaN	NaN	NaN	NaN	

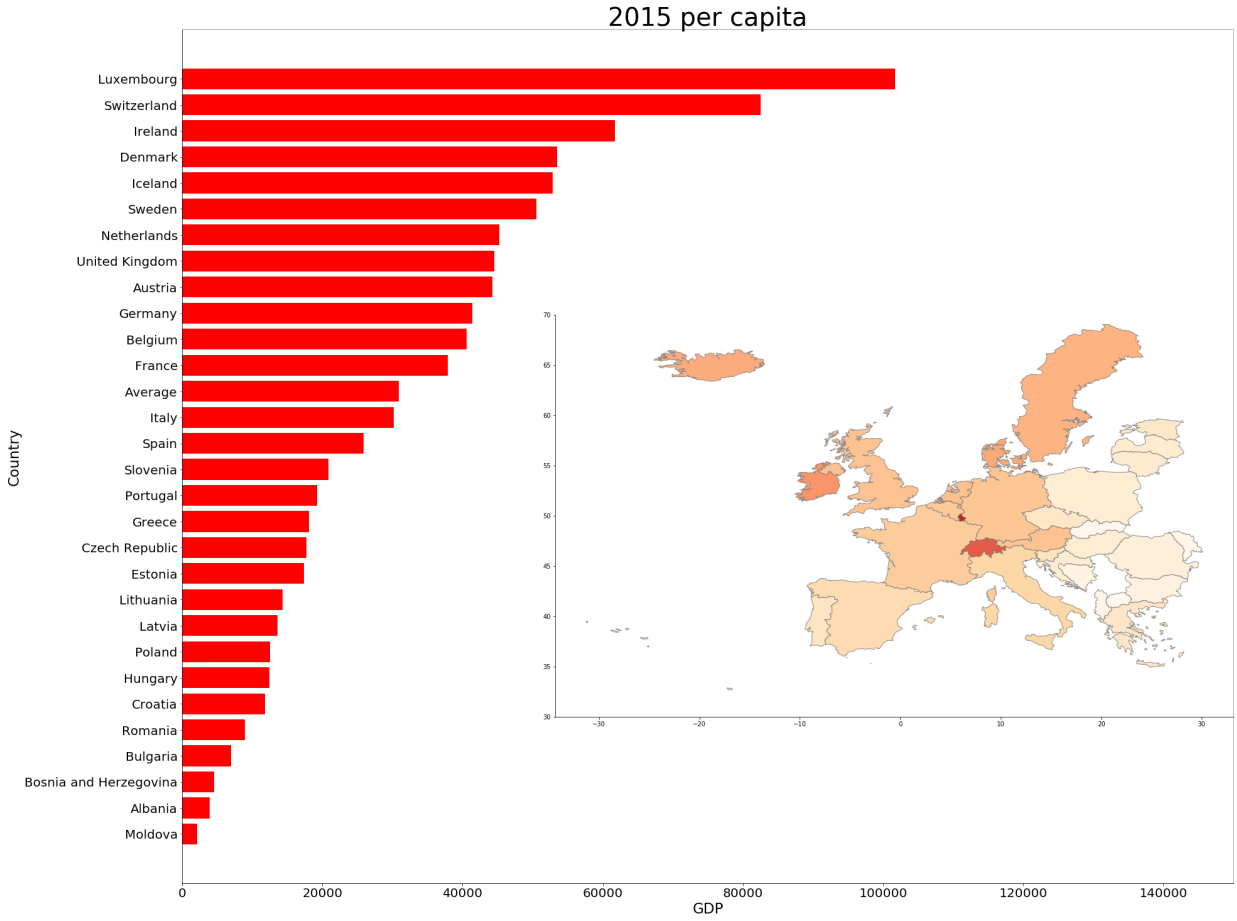
196 rows × 22 columns

In [64]:
```
for year in year_list:
    bar_graph_df[str(year) + " per capita"] = gdp_per_capita_data[year
]
```

In [65]:
```
bar_graph_df.loc['Average']=bar_graph_df.mean()
```

In [66]:
```
for year in year_list:
    europe_map[str(year) + " per capita"] = gdp_per_capita_data[year]
```

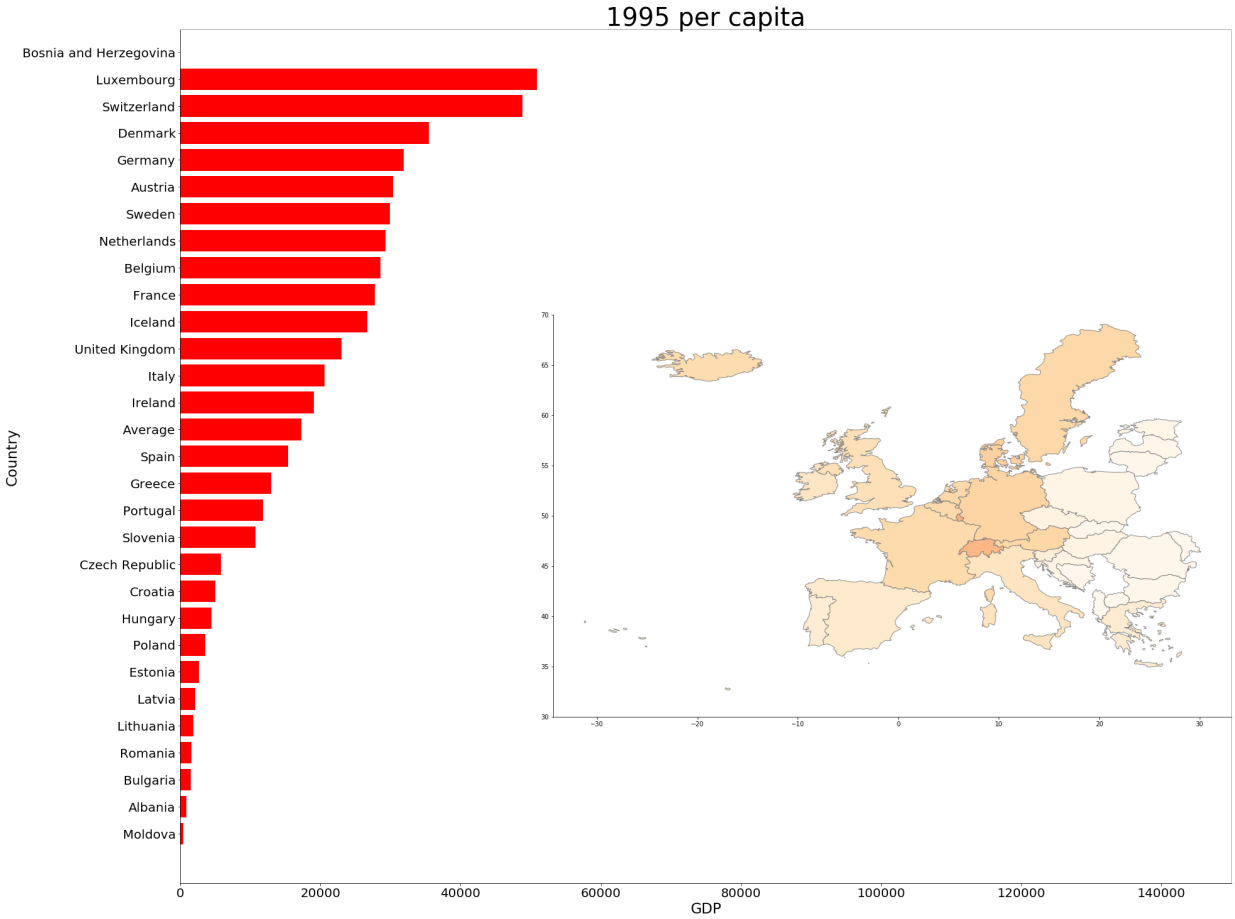
In [67]:
```
sort_barchart("2015 per capita")
final_plot("2015 per capita", 120000,150000)
```



In [68]:
```
year_per_capita_list = []

for year in year_list:
    year_per_capita_list.append(str(year)+" per capita")
```

In [69]:
```
for year in year_per_capita_list:
    sort_barchart(year)
    final_plot(year, 120000,150000)
```


1995 per capita
Bosnia and Herzegovina
Luxembourg
Switzerland
Denmark
Germany
Austria
Sweden
Netherlands
Belgium
France
Iceland
United Kingdom
Italy
Ireland
Average
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Greece
Portugal
Slovenia
Czech Republic
Croatia
Hungary
Poland
Estonia
Latvia
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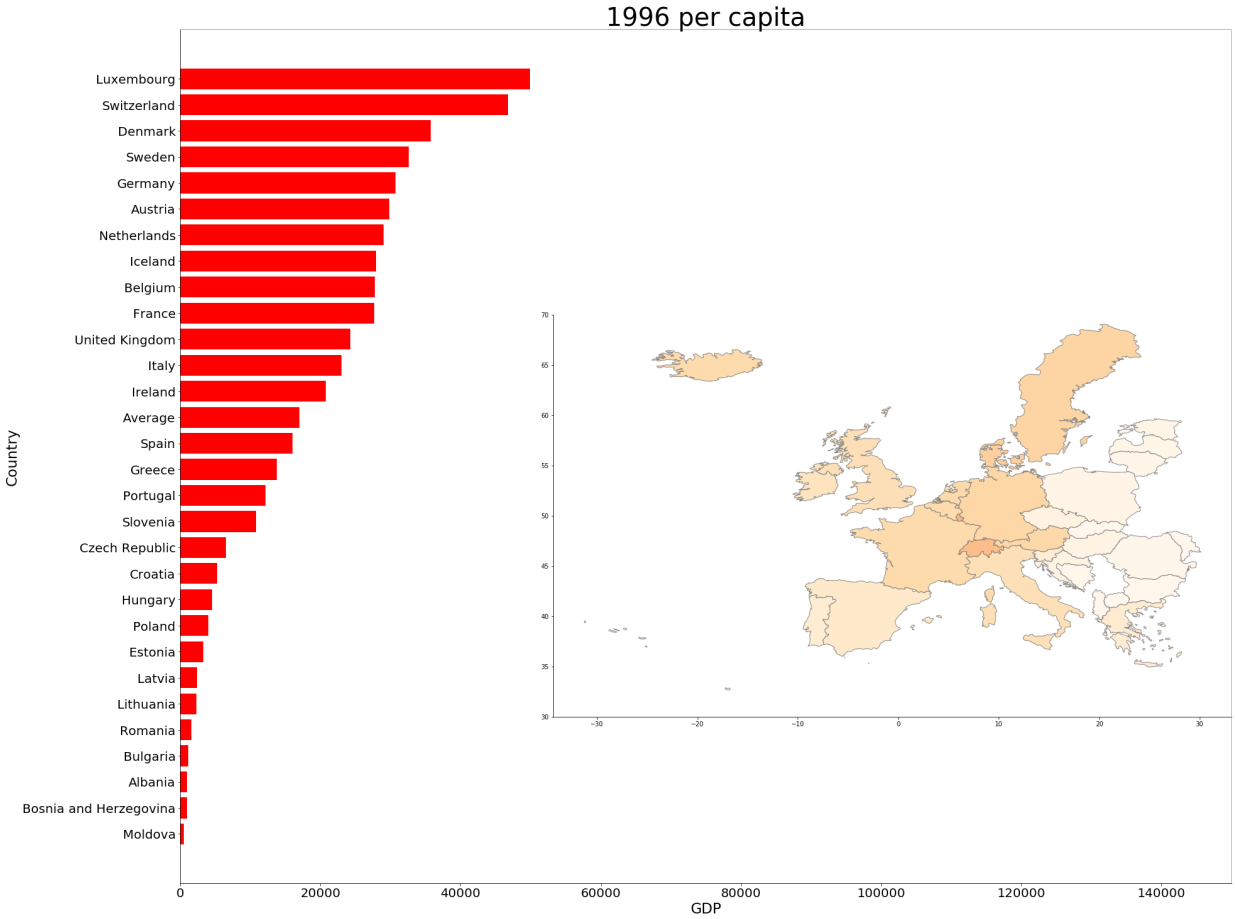
GDP


1996 per capita
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Portugal
Slovenia
Czech Republic
Croatia
Hungary
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Romania
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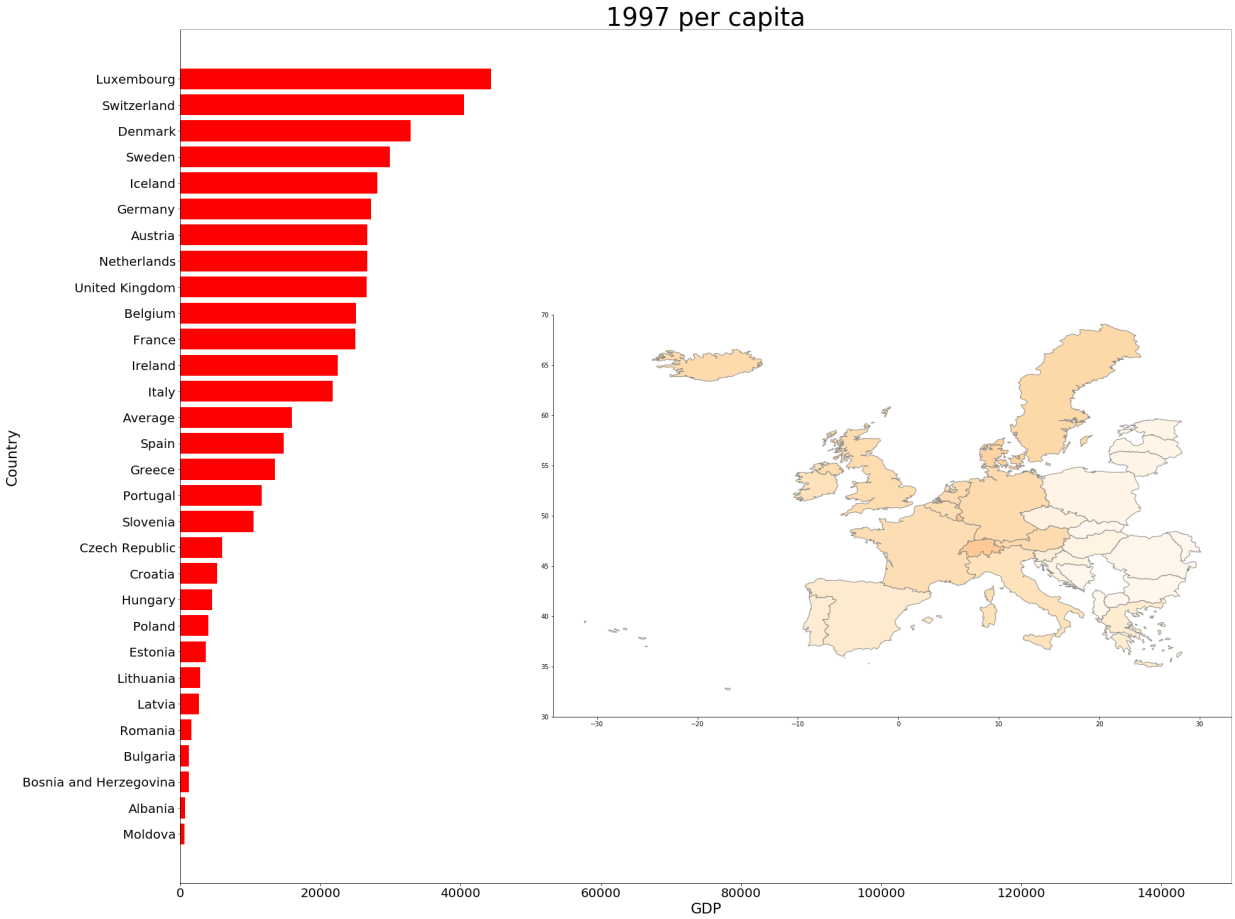
1997 per capita
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Croatia
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Lithuania
Latvia
Romania
Bulgaria
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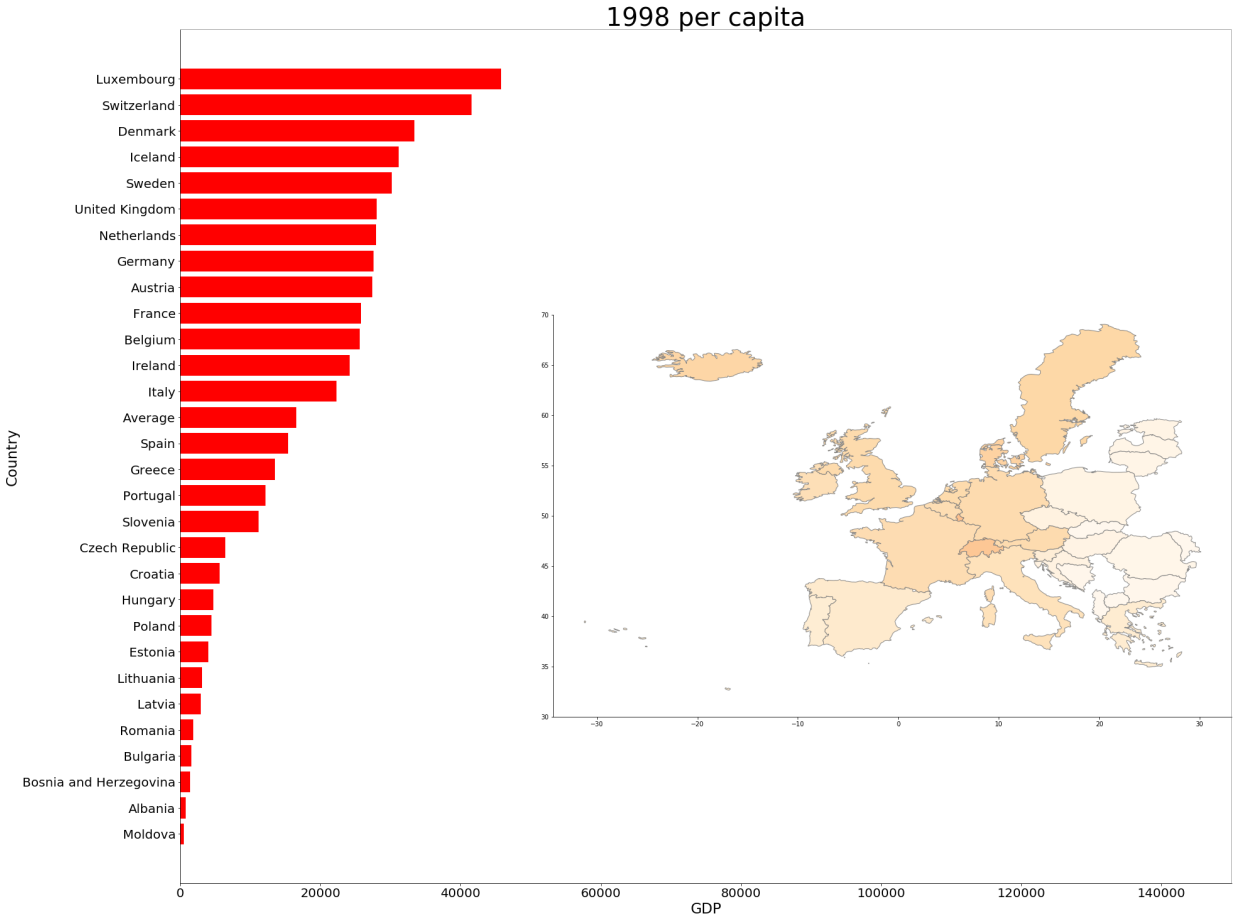
1998 per capita
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Latvia
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Bulgaria
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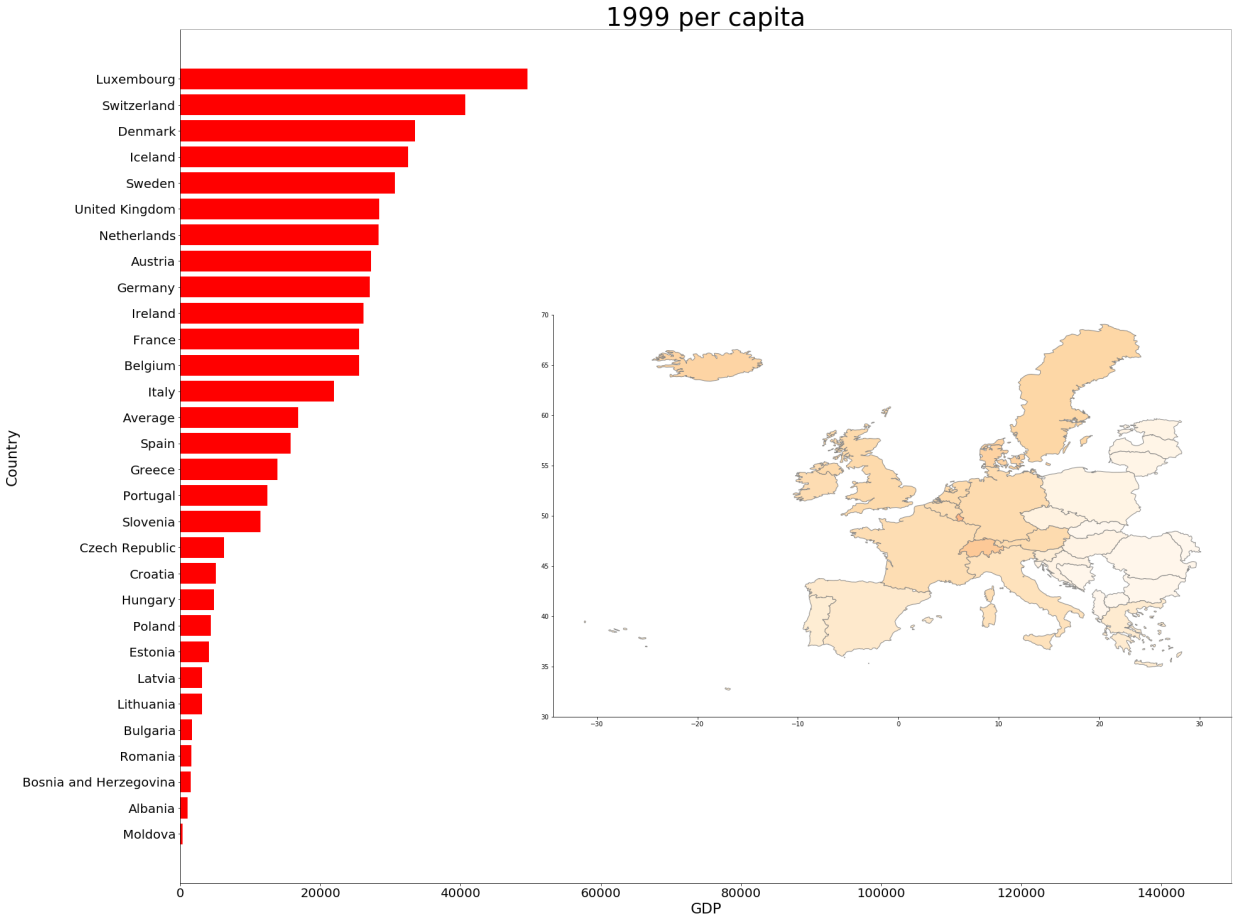
1999 per capita
Luxembourg
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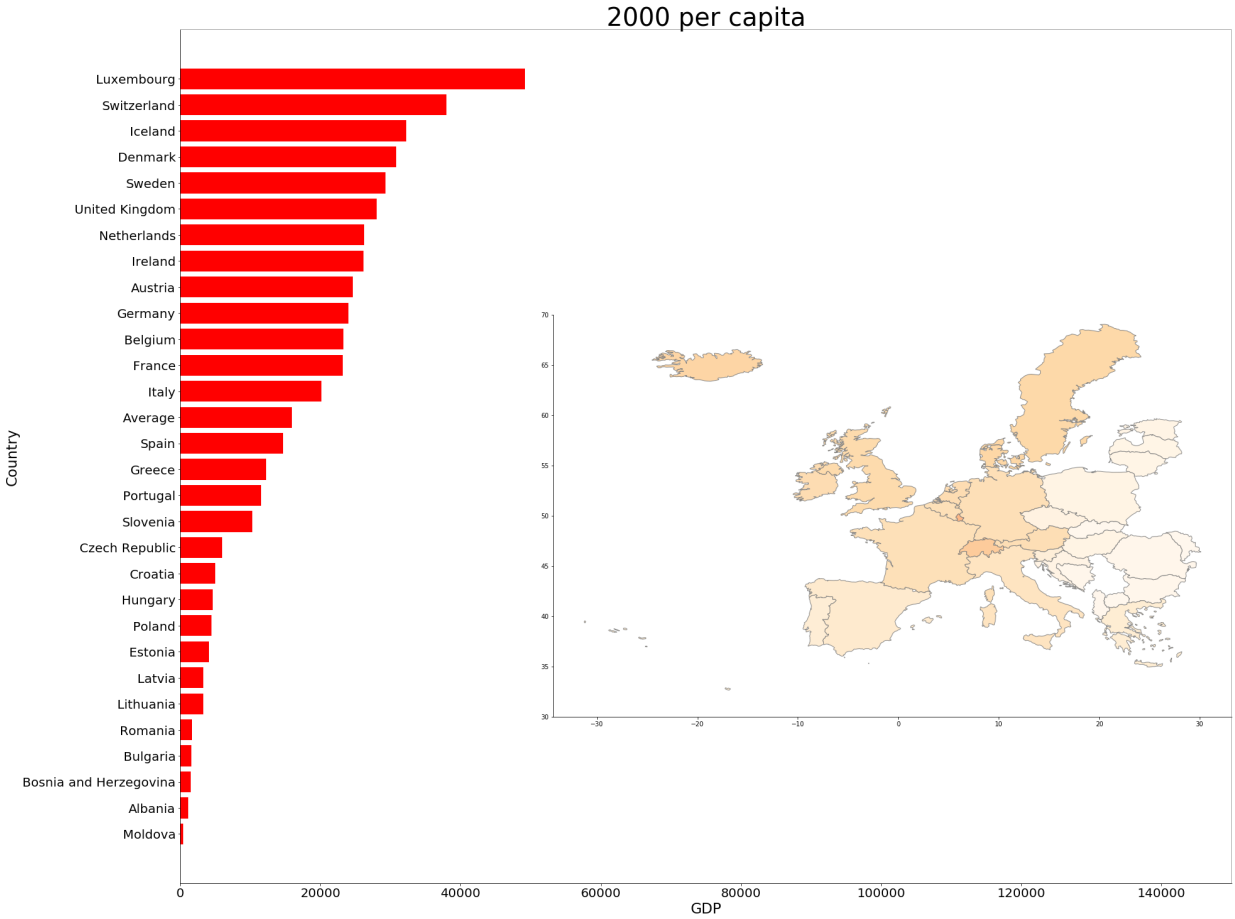
2000 per capita
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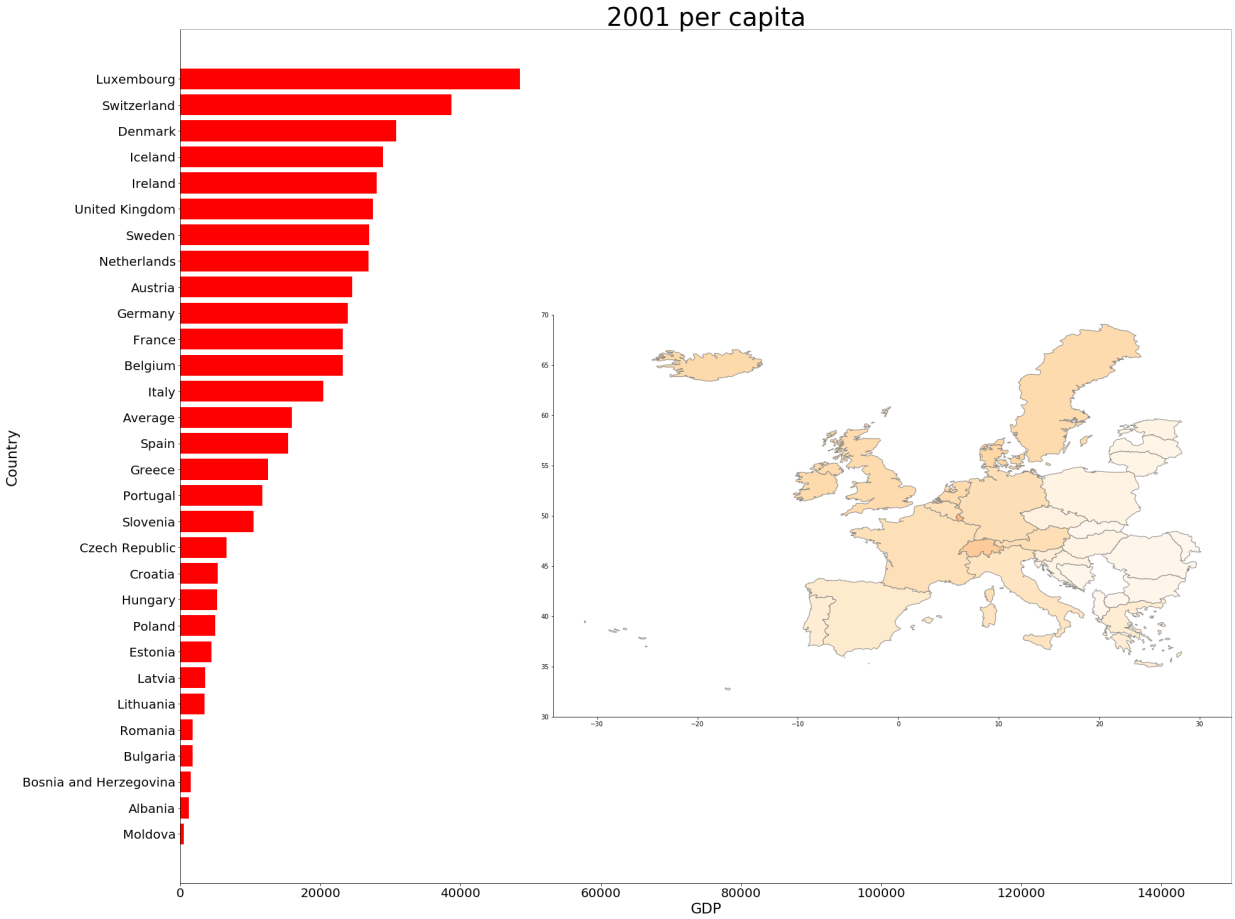
2001 per capita
Luxembourg
Switzerland
Denmark
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United Kingdom
Sweden
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Average
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Greece
Portugal
Slovenia
Czech Republic
Croatia
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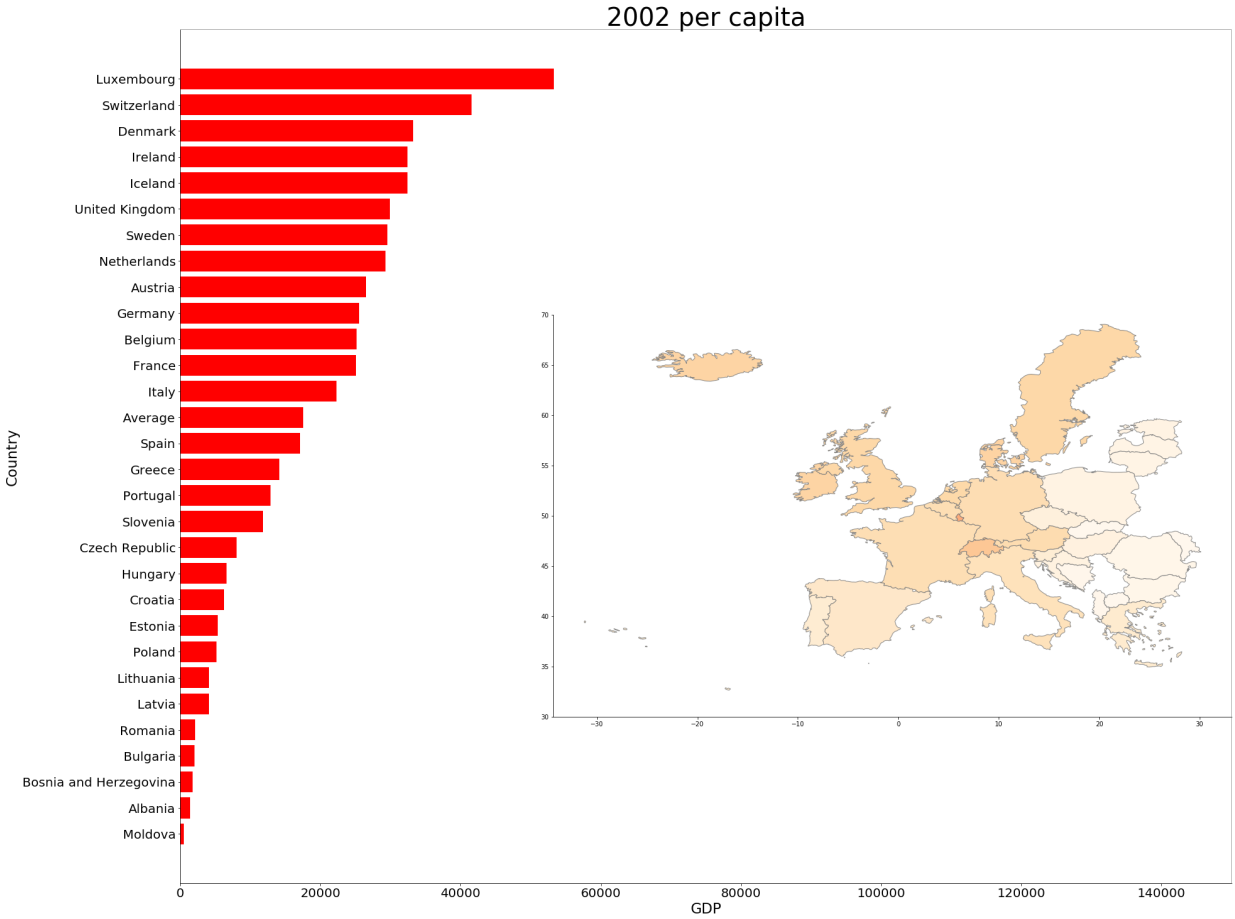
2002 per capita
Luxembourg
Switzerland
Denmark
Ireland
Iceland
United Kingdom
Sweden
Netherlands
Austria
Germany
Belgium
France
Italy
Average
Spain
Greece
Portugal
Slovenia
Czech Republic
Hungary
Croatia
Estonia
Poland
Lithuania
Latvia
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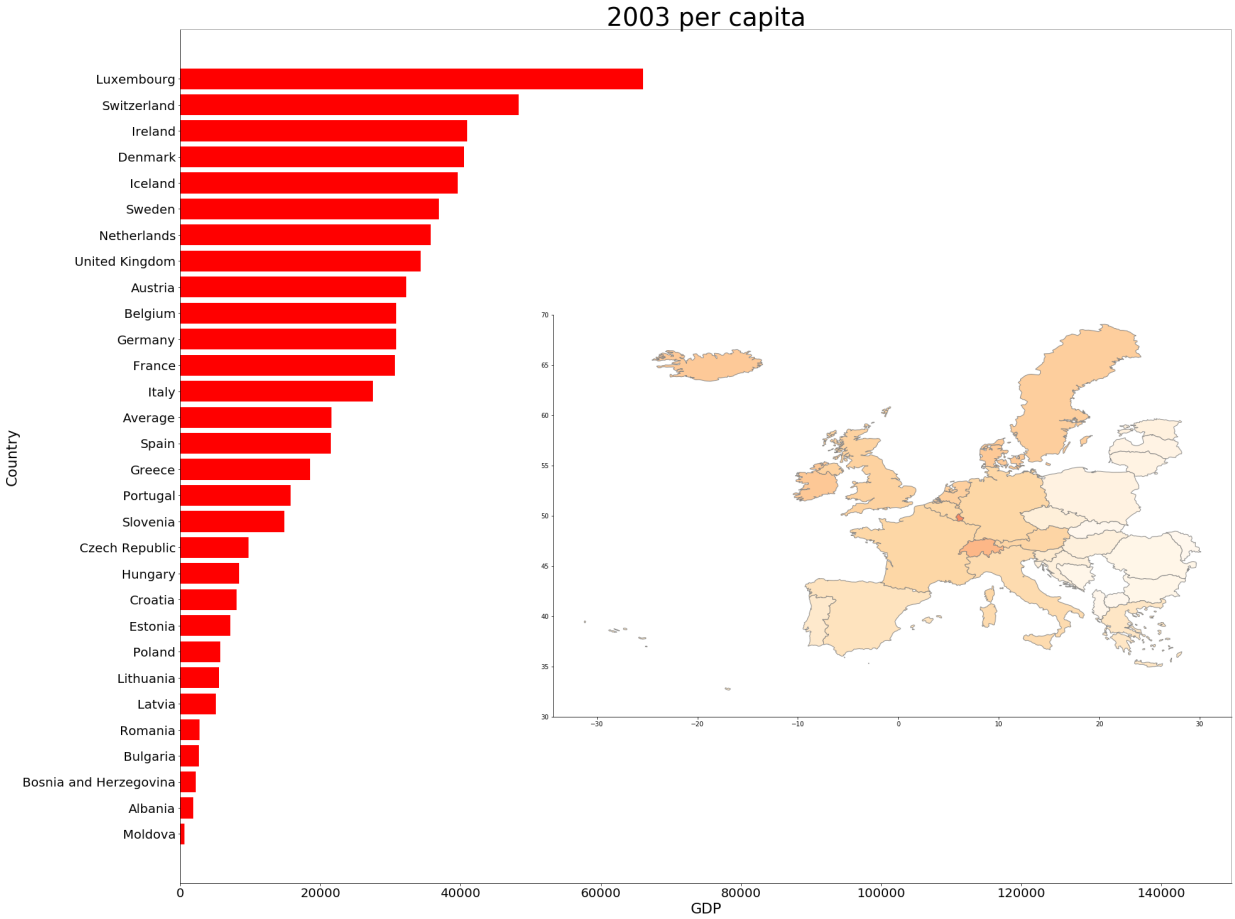
2003 per capita
Luxembourg
Switzerland
Ireland
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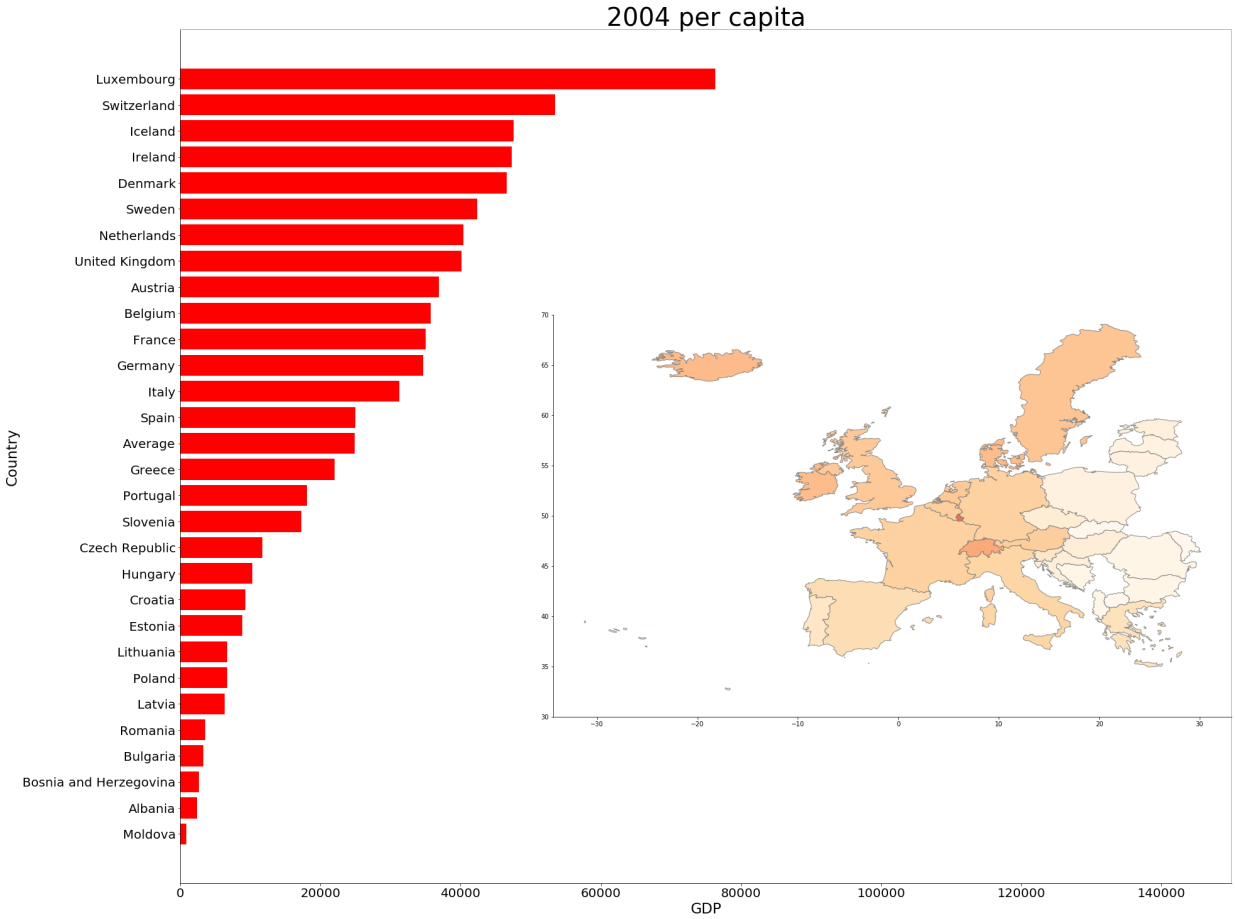
2004 per capita
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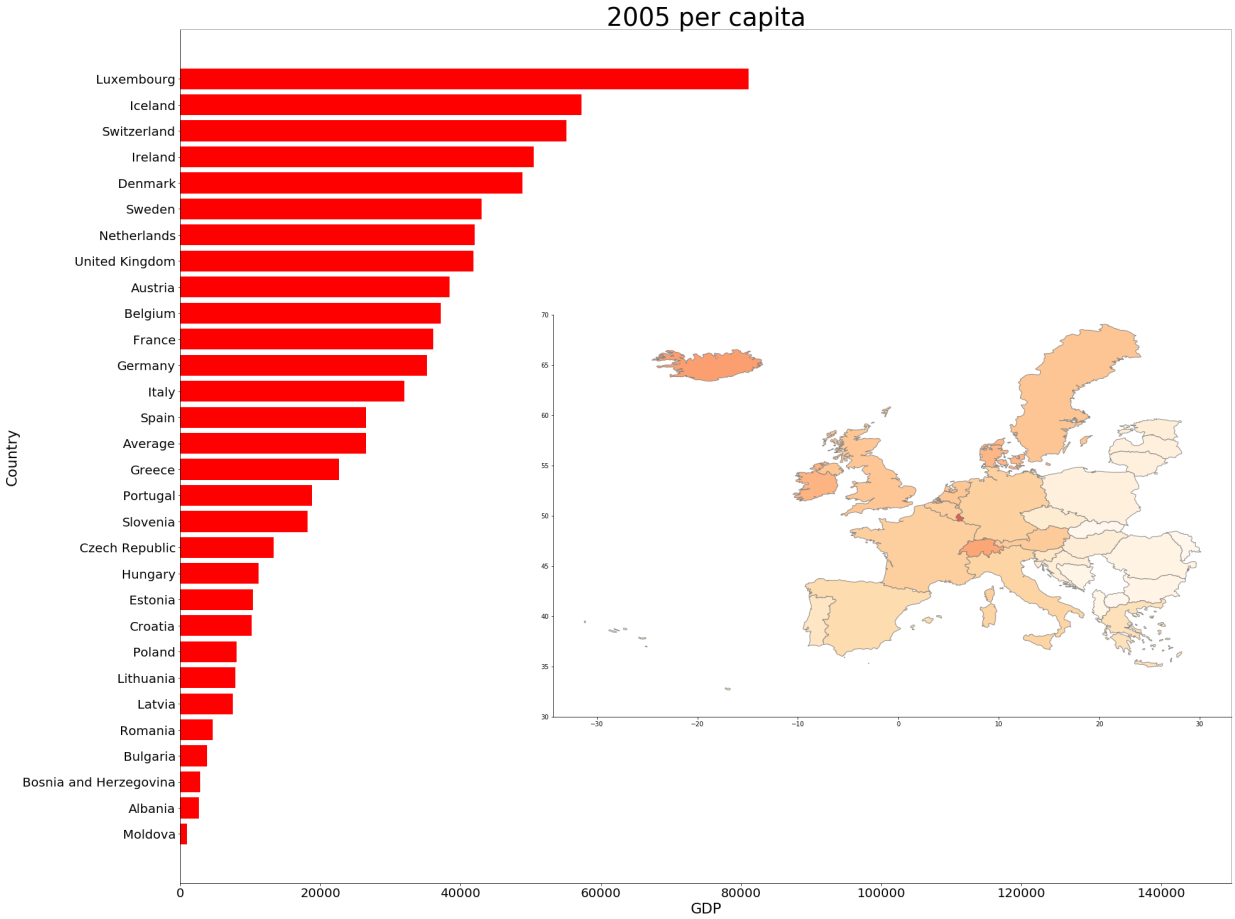
2005 per capita
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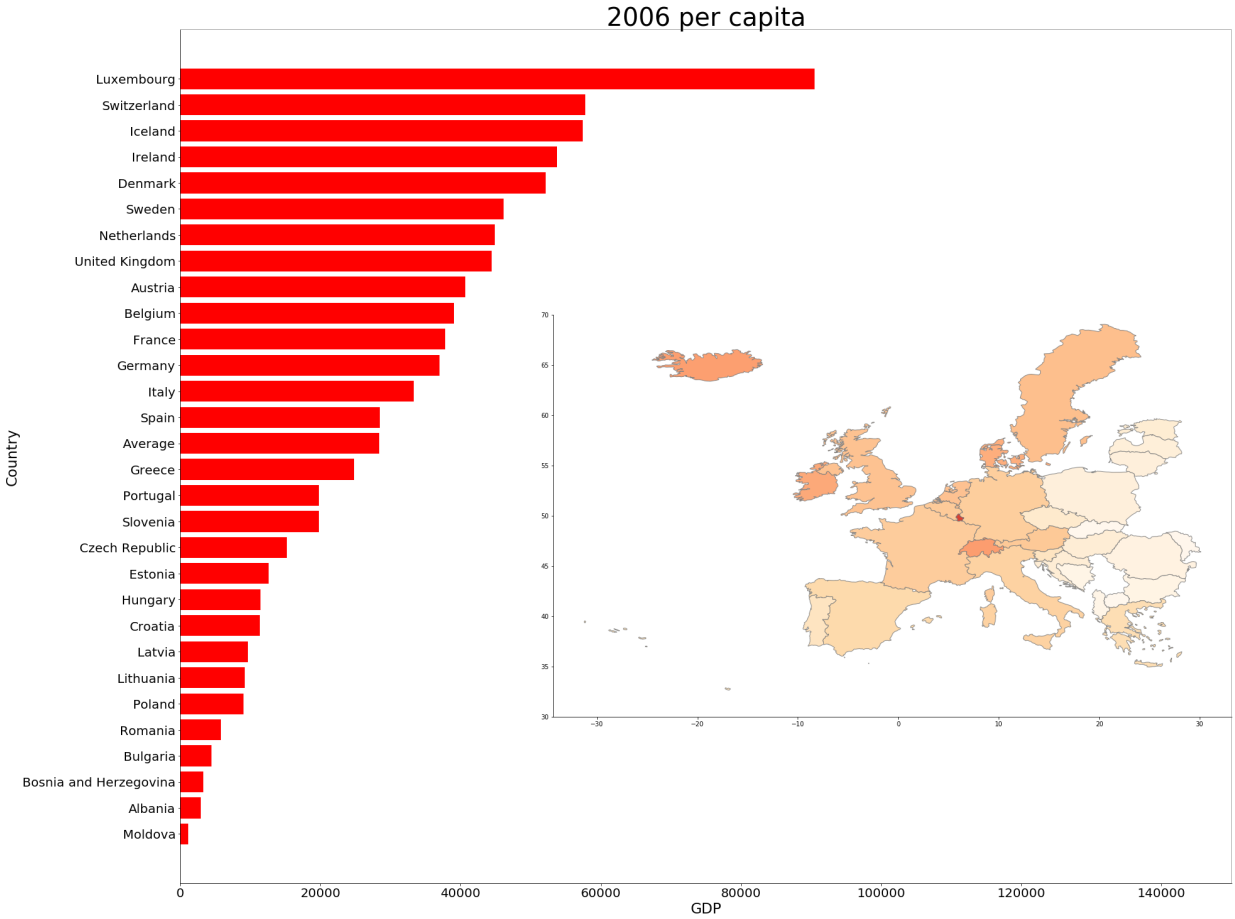
2006 per capita
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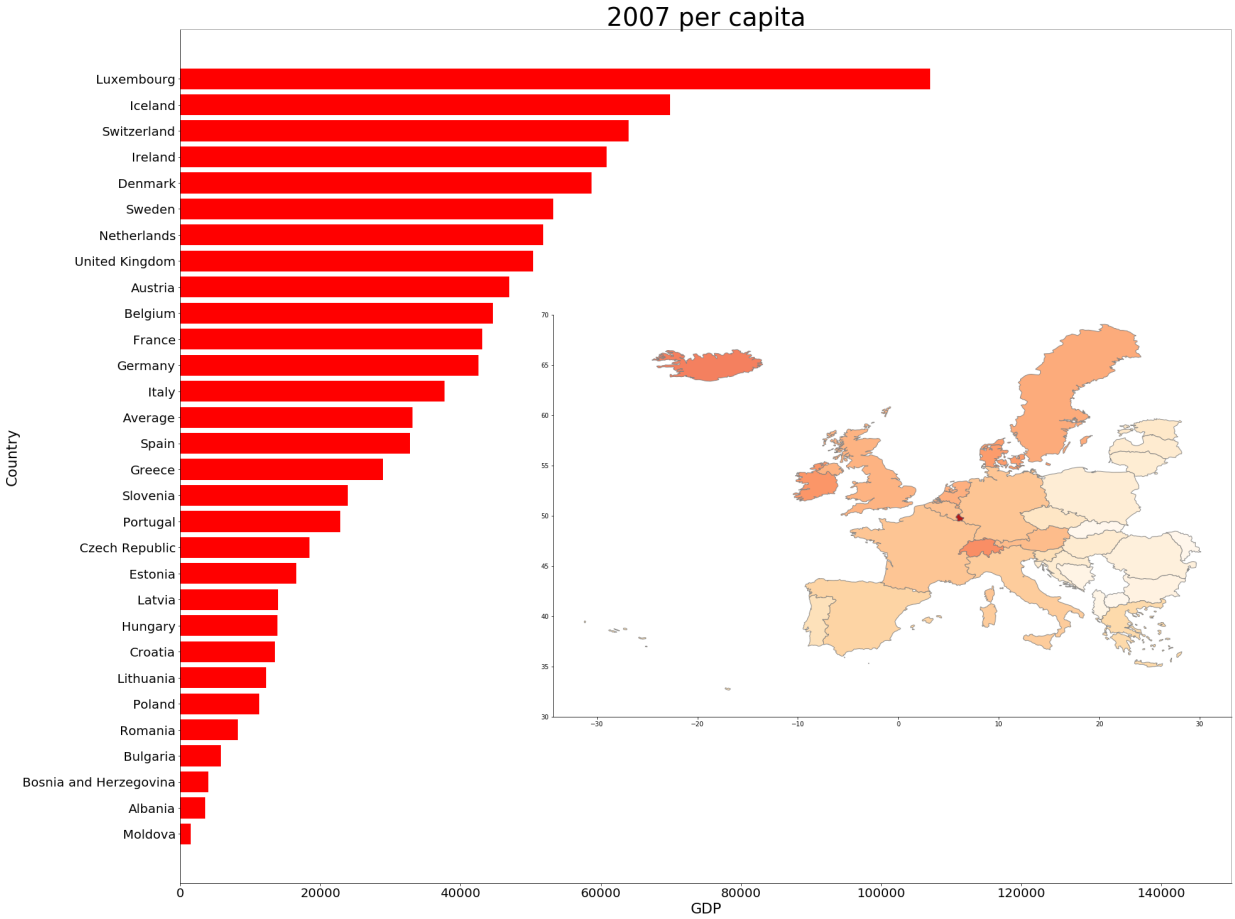
2007 per capita
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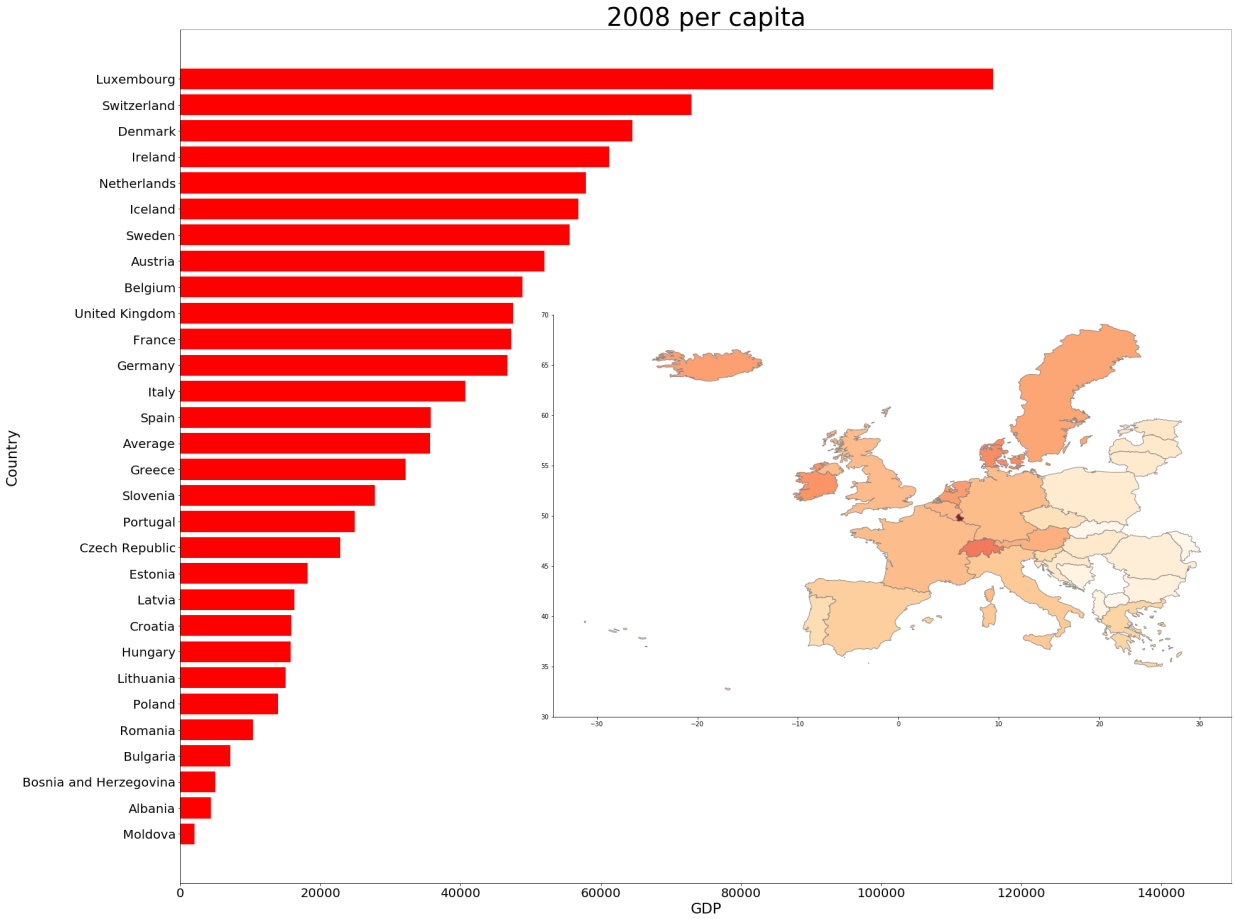
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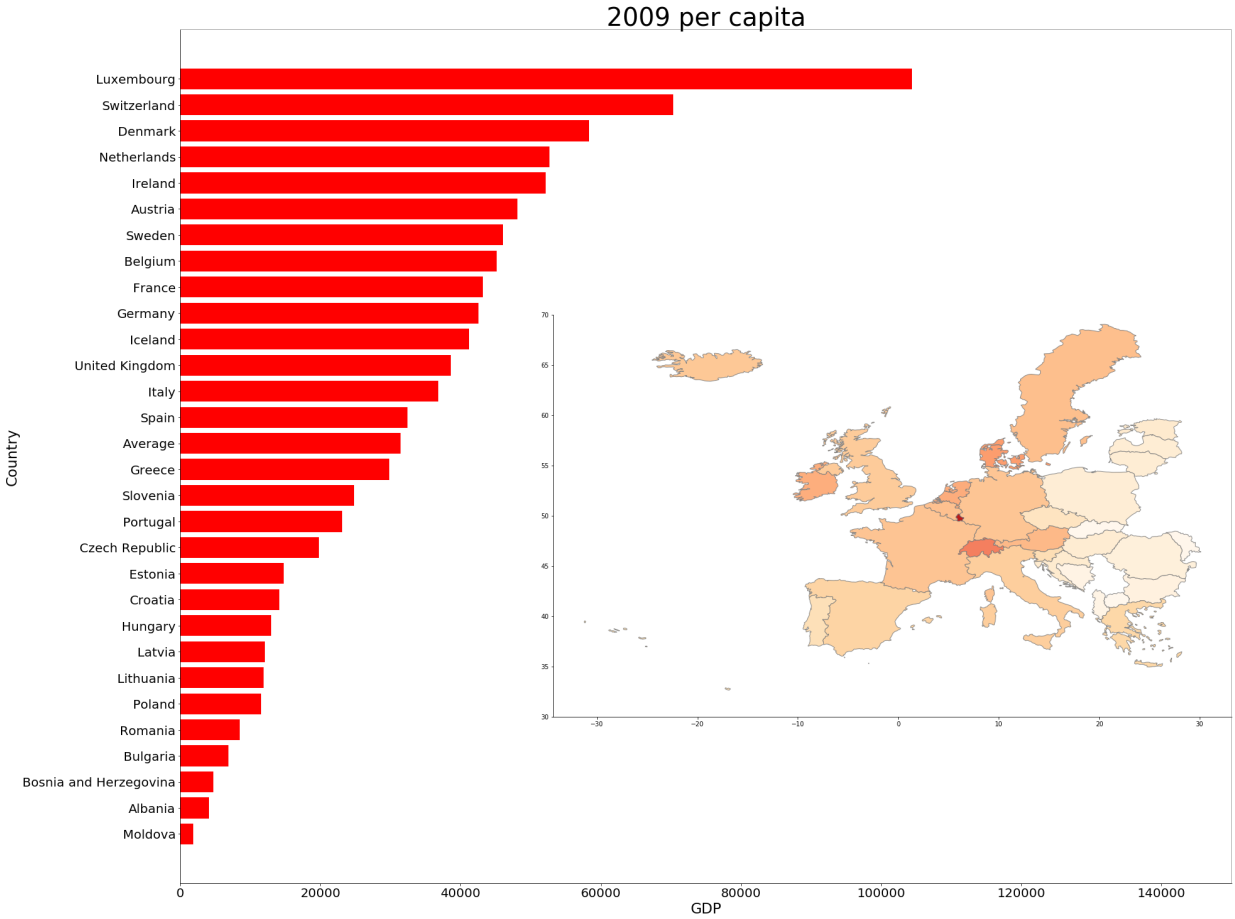
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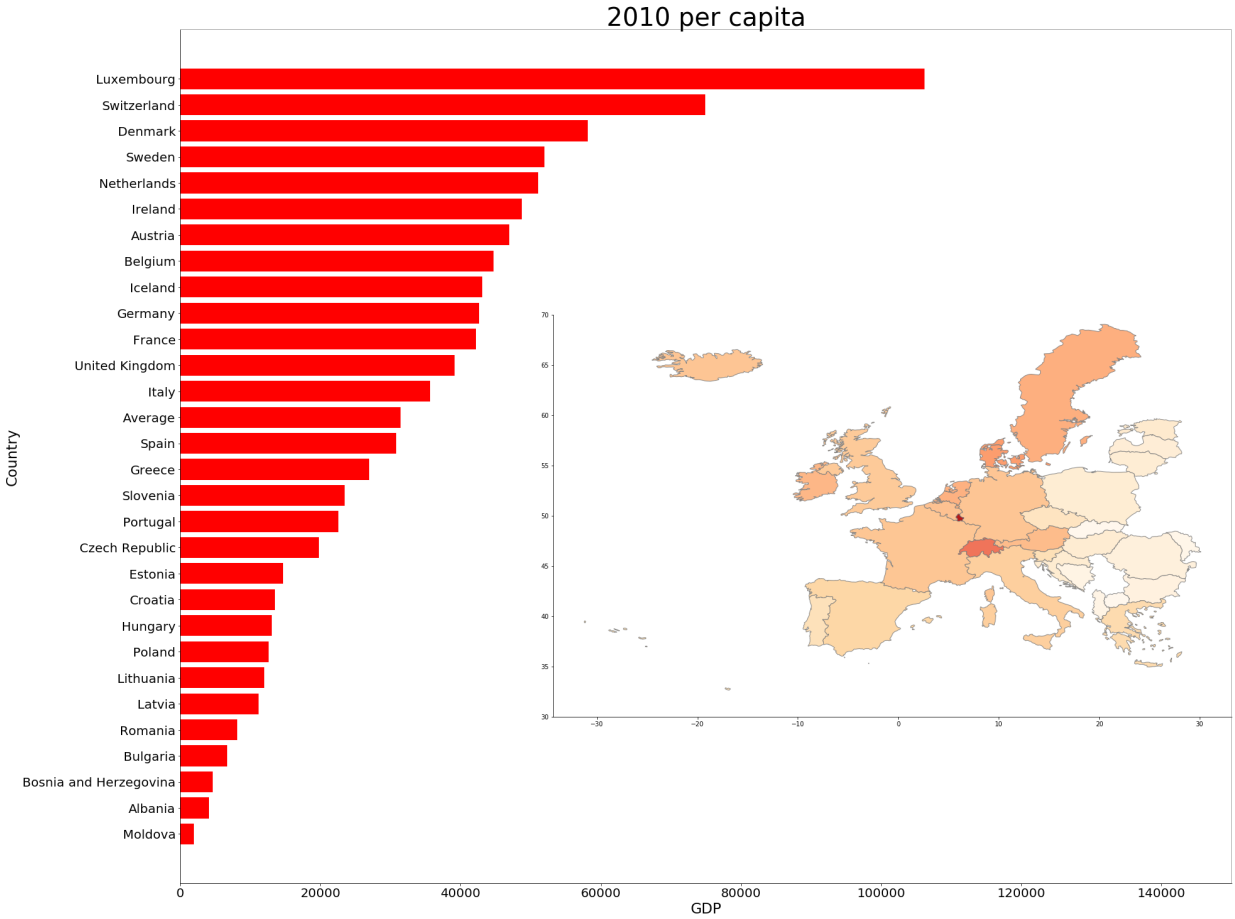
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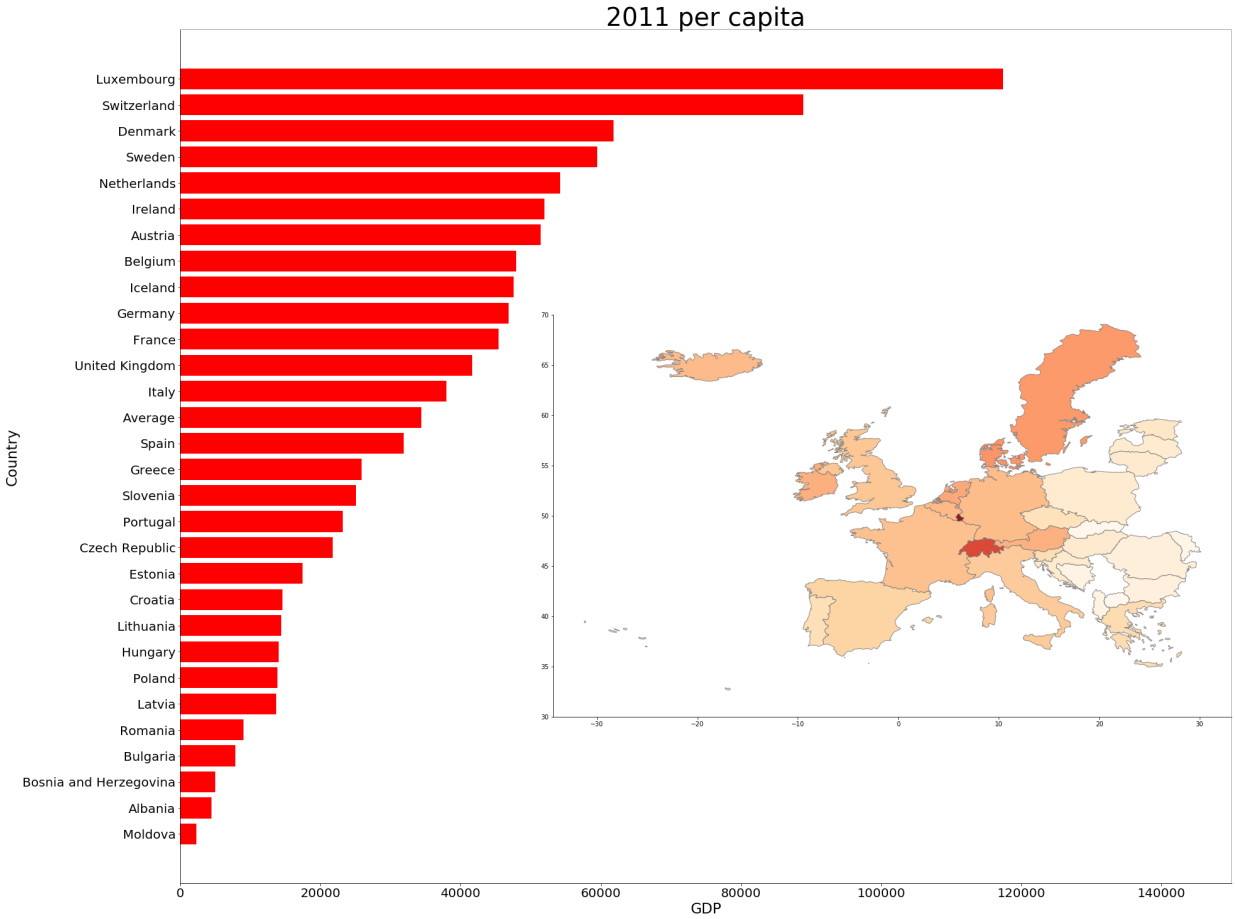
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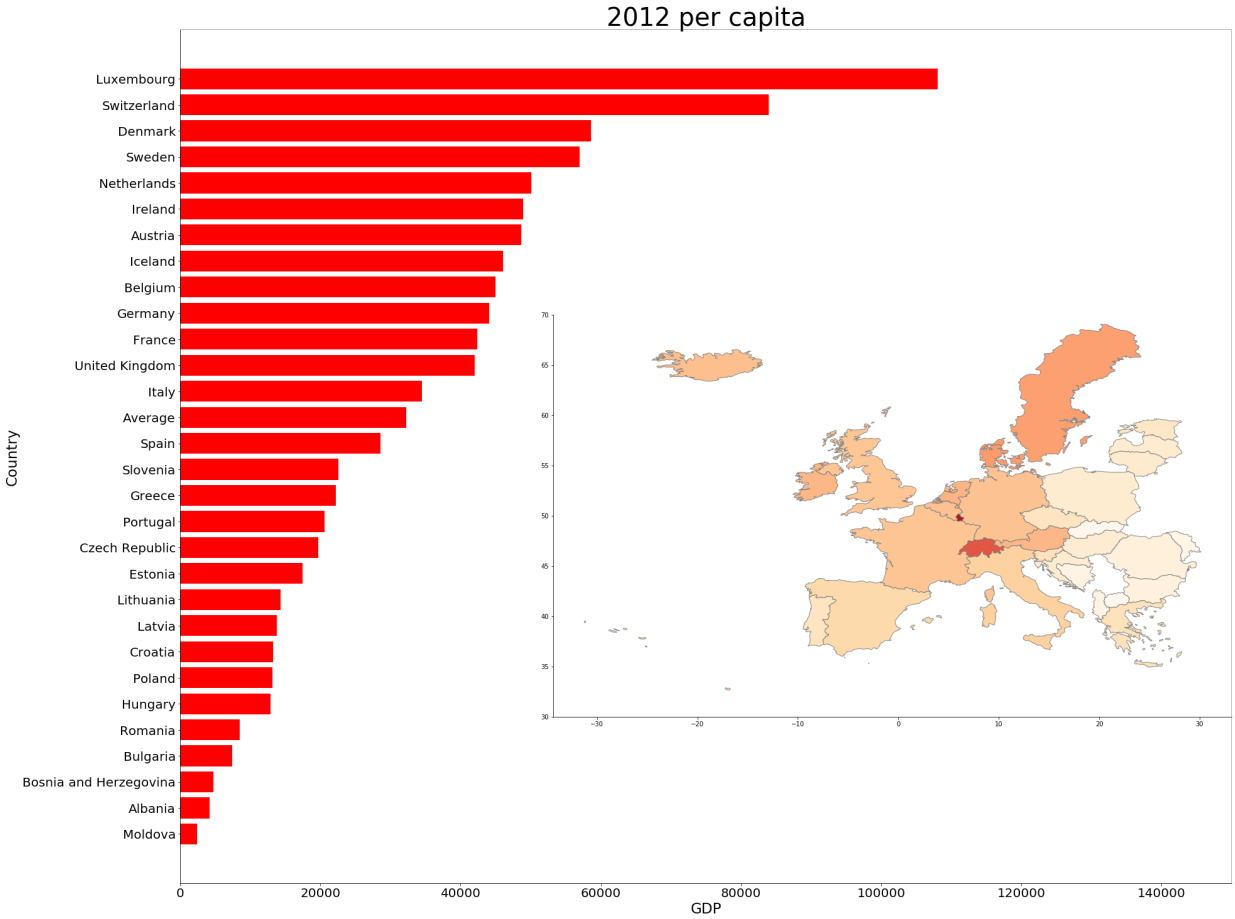
2012 per capita
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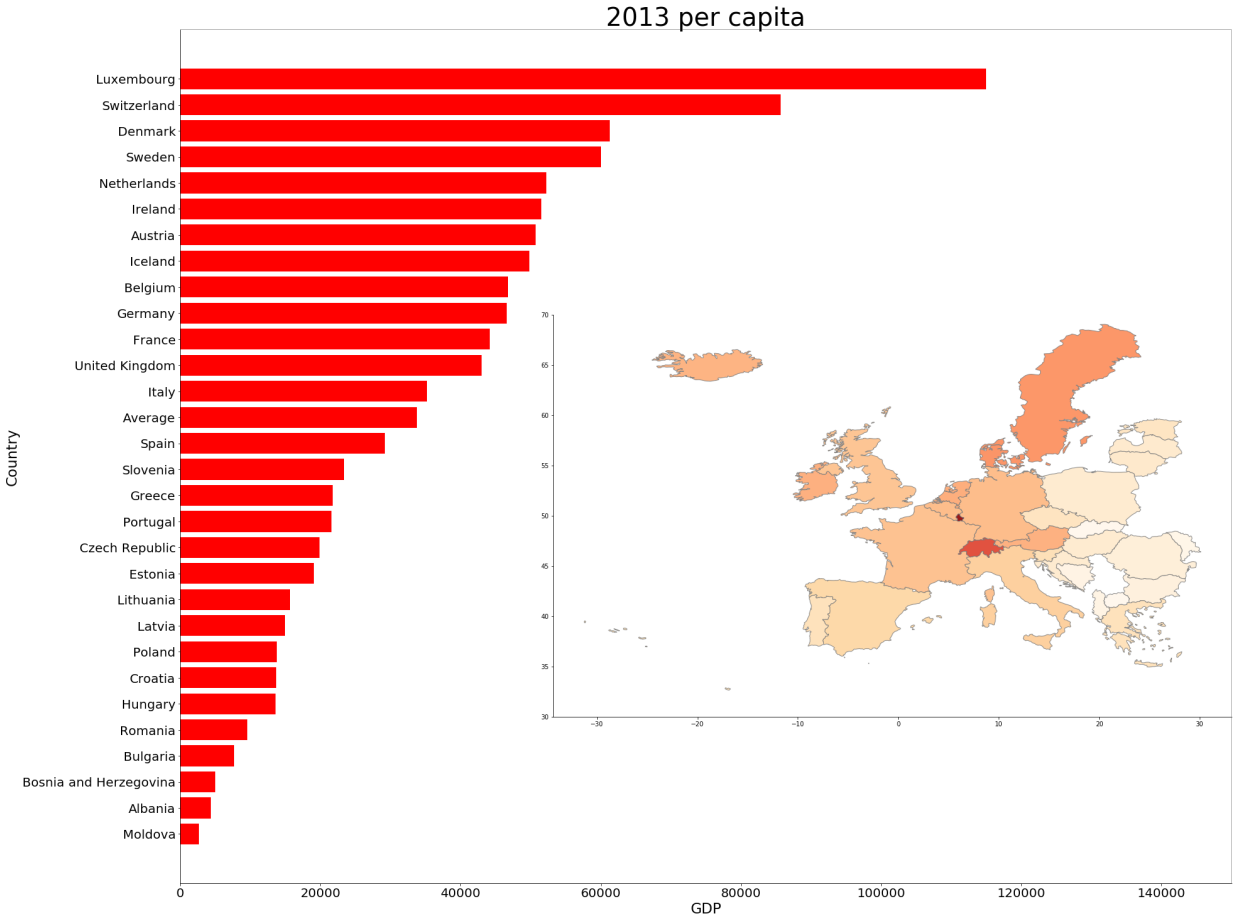
2013 per capita
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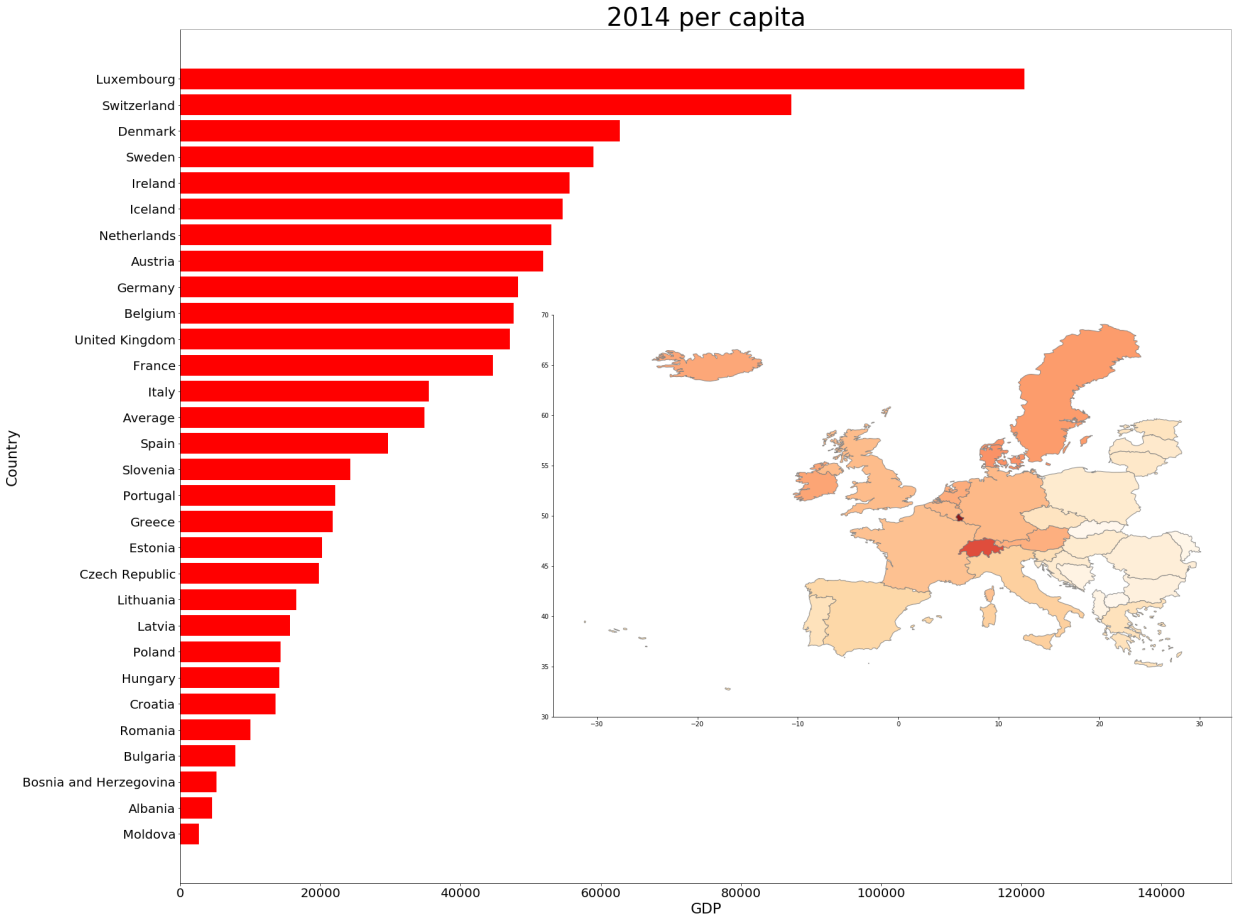
2014 per capita
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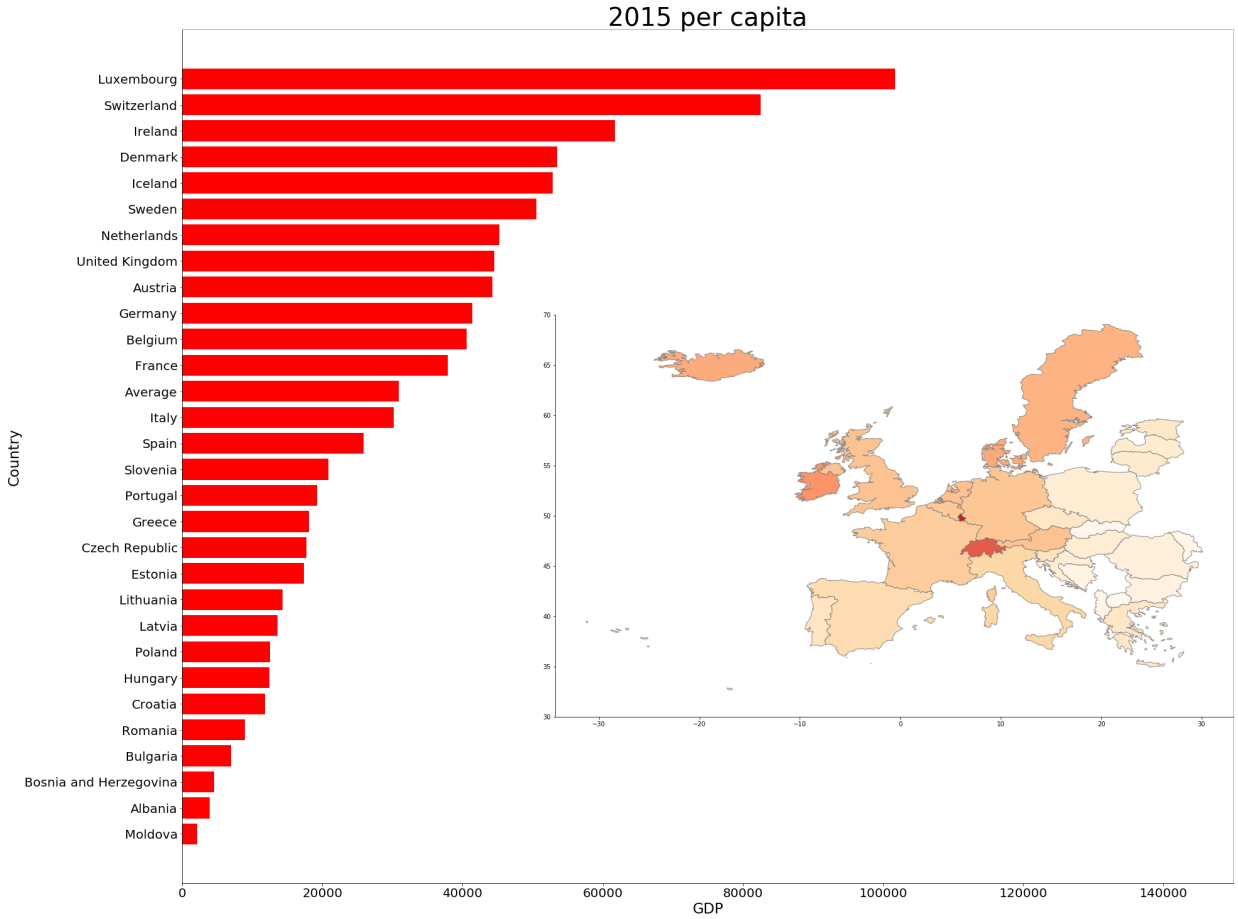

In [70]:
```
per_capita_pic_list = []

for year in year_per_capita_list:
    per_capita_pic_list.append(str(year)+".png")
```

In [71]:
```
year_list
```

Out[71]:
```
[1995,
 1996,
 1997,
 1998,
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 2004,
 2005,
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 2007,
 2008,
 2009,
 2010,
 2011,
 2012,
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 2014,
 2015]
```

In [72]:
```
pcimages = []
```

In [73]:
```
for filename in per_capita_pic_list:
    pcimages.append(imageio.imread(os.getcwd() + "/FinalOutput/" + fil
ename))
    imageio.mimsave(finaloutputpercapitagif, pcimages, duration = 1)
```

Below, I will be charting the log of the GDP per Capita data:

In [74]:
```
year_per_capita_list
```

Out[74]:
```
['1995 per capita',
 '1996 per capita',
 '1997 per capita',
 '1998 per capita',
 '1999 per capita',
 '2000 per capita',
 '2001 per capita',
 '2002 per capita',
 '2003 per capita',
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 '2007 per capita',
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 '2009 per capita',
 '2010 per capita',
 '2011 per capita',
 '2012 per capita',
 '2013 per capita',
 '2014 per capita',
 '2015 per capita']
```

In [75]:
```
for year in year_list:
    europe_map[str(year) + " per capita log"] = np.log(gdp_per_capita_
data[year])
```

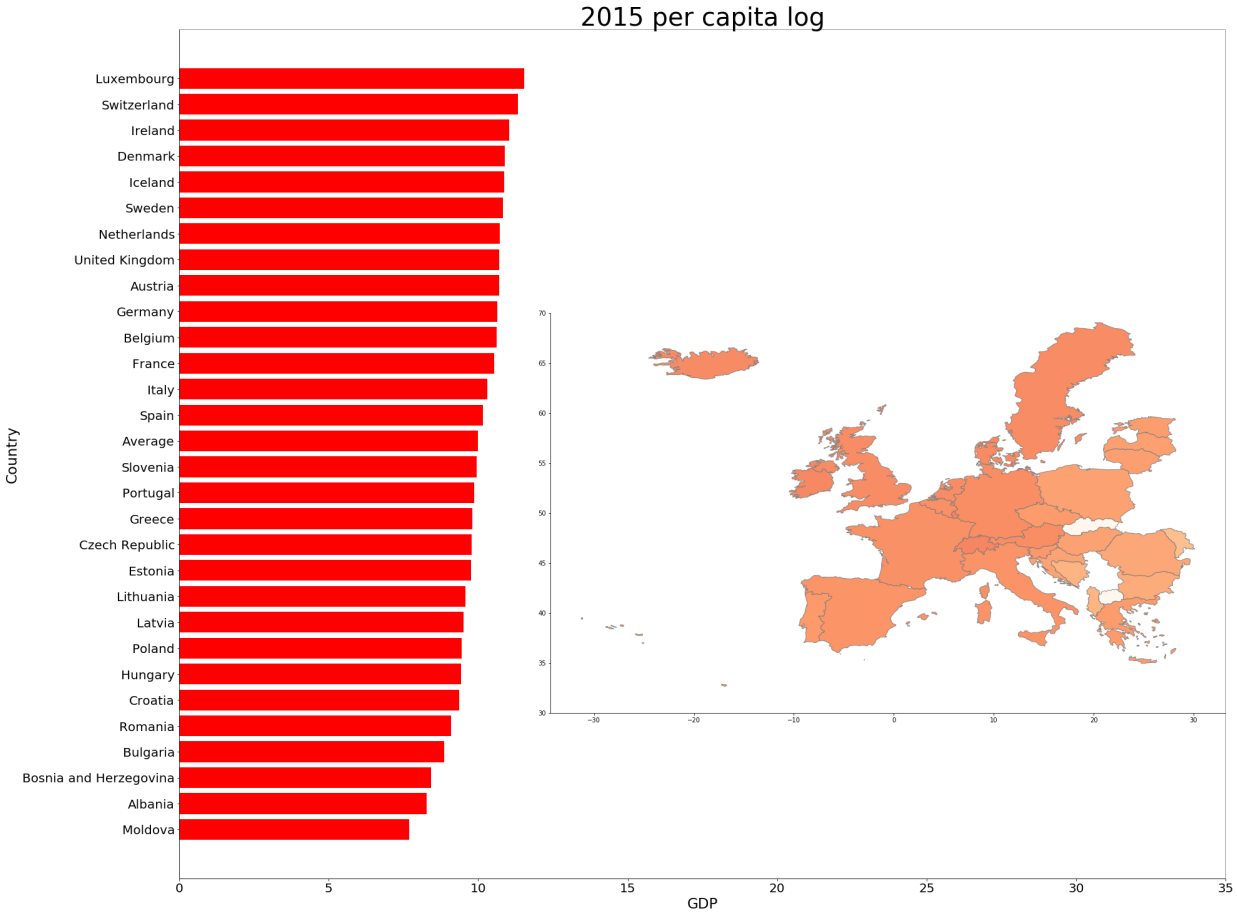
In [76]:
```
year_per_capita_log_list = []

for year in year_list:
    year_per_capita_log_list.append(str(year)+" per capita log")
```

In [77]:
```
for year in year_list:
    bar_graph_df[str(year) + " per capita log"] = np.log(gdp_per_capit
a_data[year])
```

In [78]:
```
bar_graph_df.loc['Average']=bar_graph_df.mean()
```

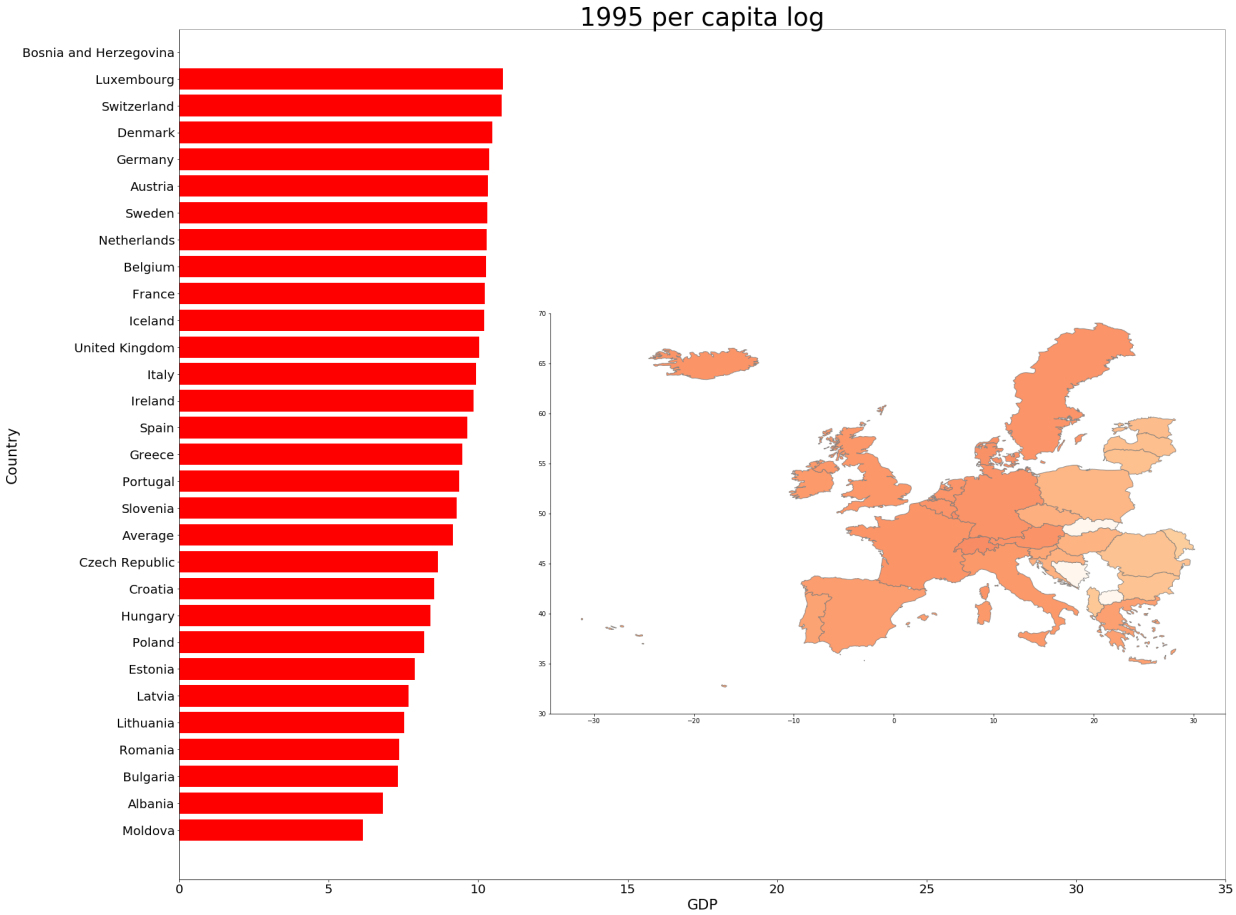
In [79]:
```
sort_barchart("2015 per capita log")
final_plot("2015 per capita log", 20,35)
```



In [80]:
```
year_per_capita_log_list = []

for year in year_list:
    year_per_capita_log_list.append(str(year)+" per capita log")
```

In [81]:
```
for year in year_per_capita_log_list:
    sort_barchart(year)
    final_plot(year, 20,35)
```


1995 per capita log
Bosnia and Herzegovina
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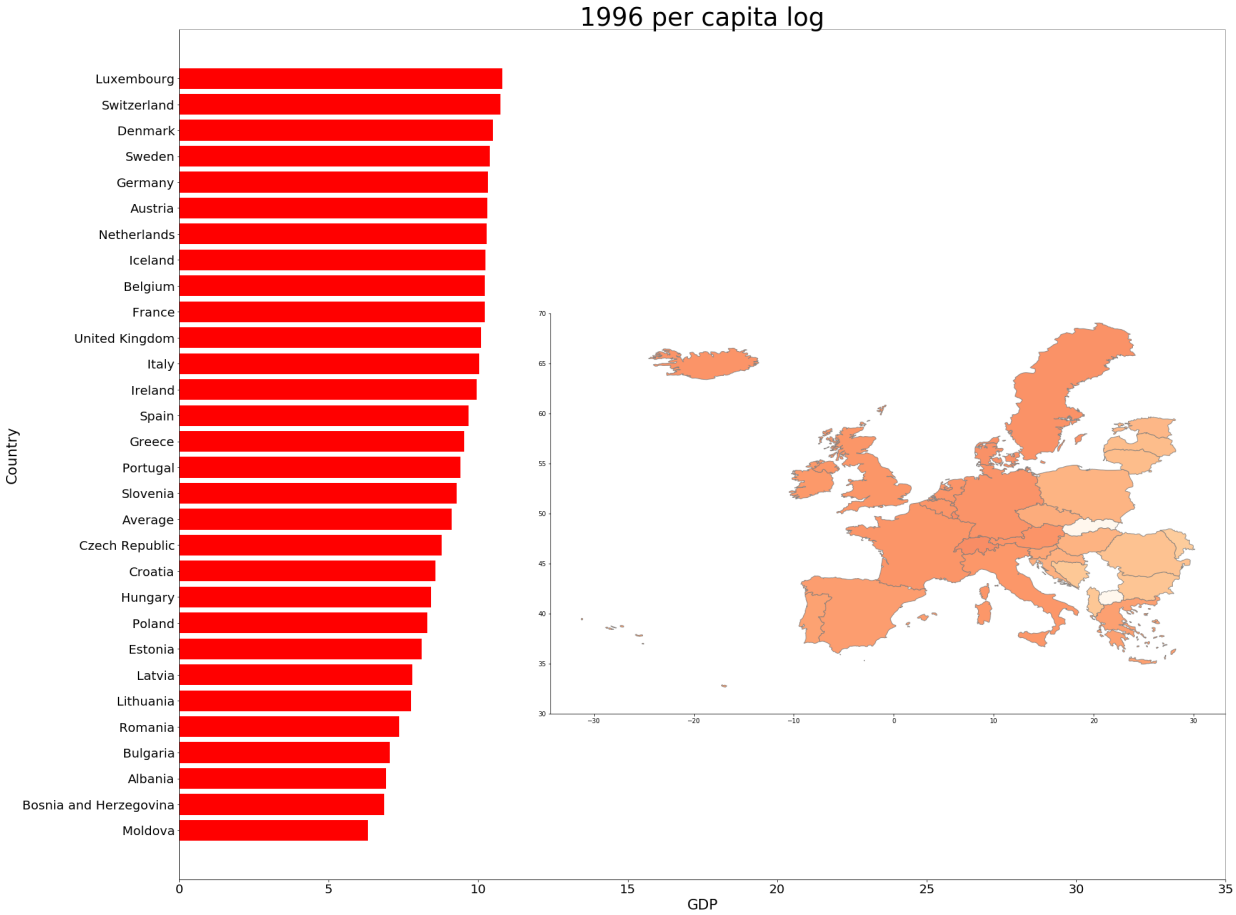
1996 per capita log
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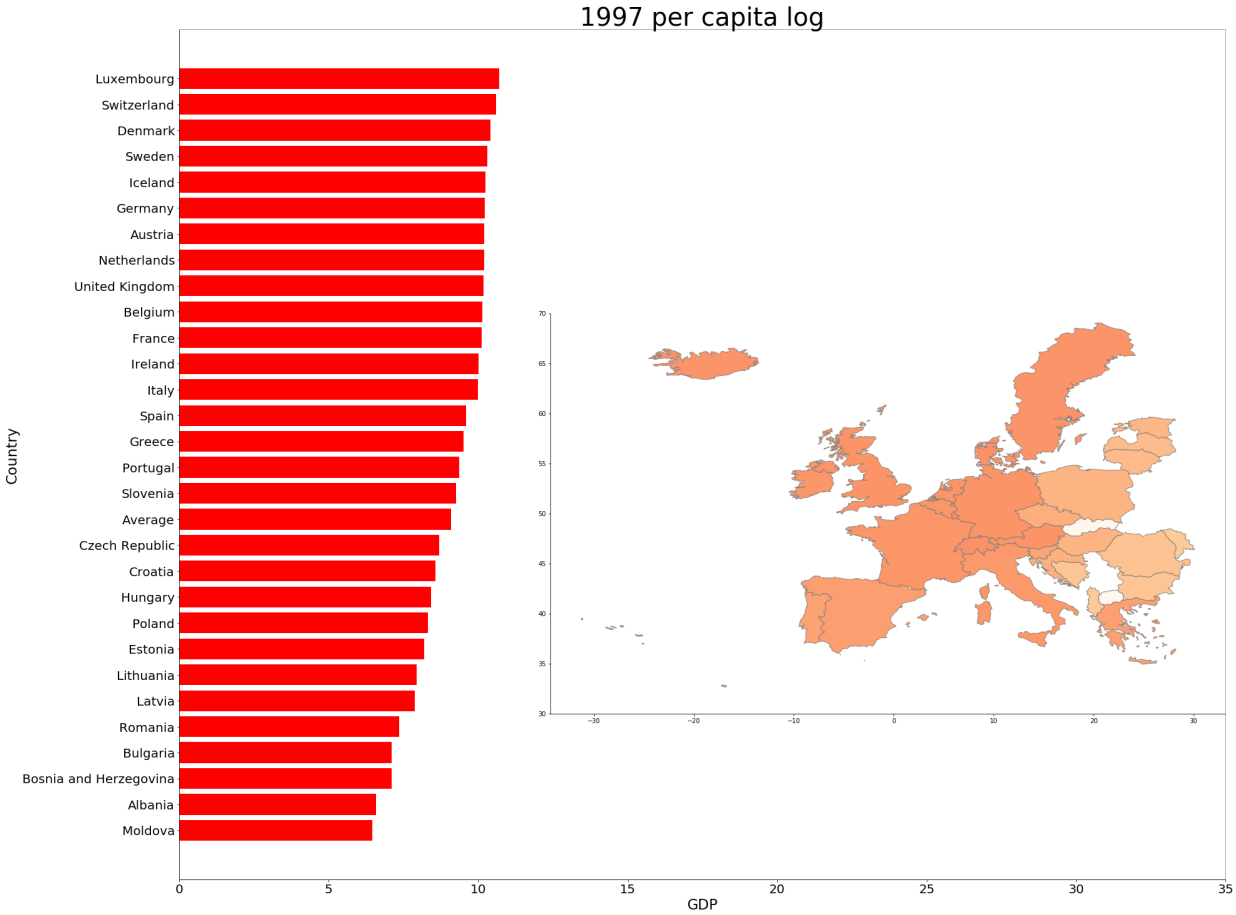
1997 per capita log
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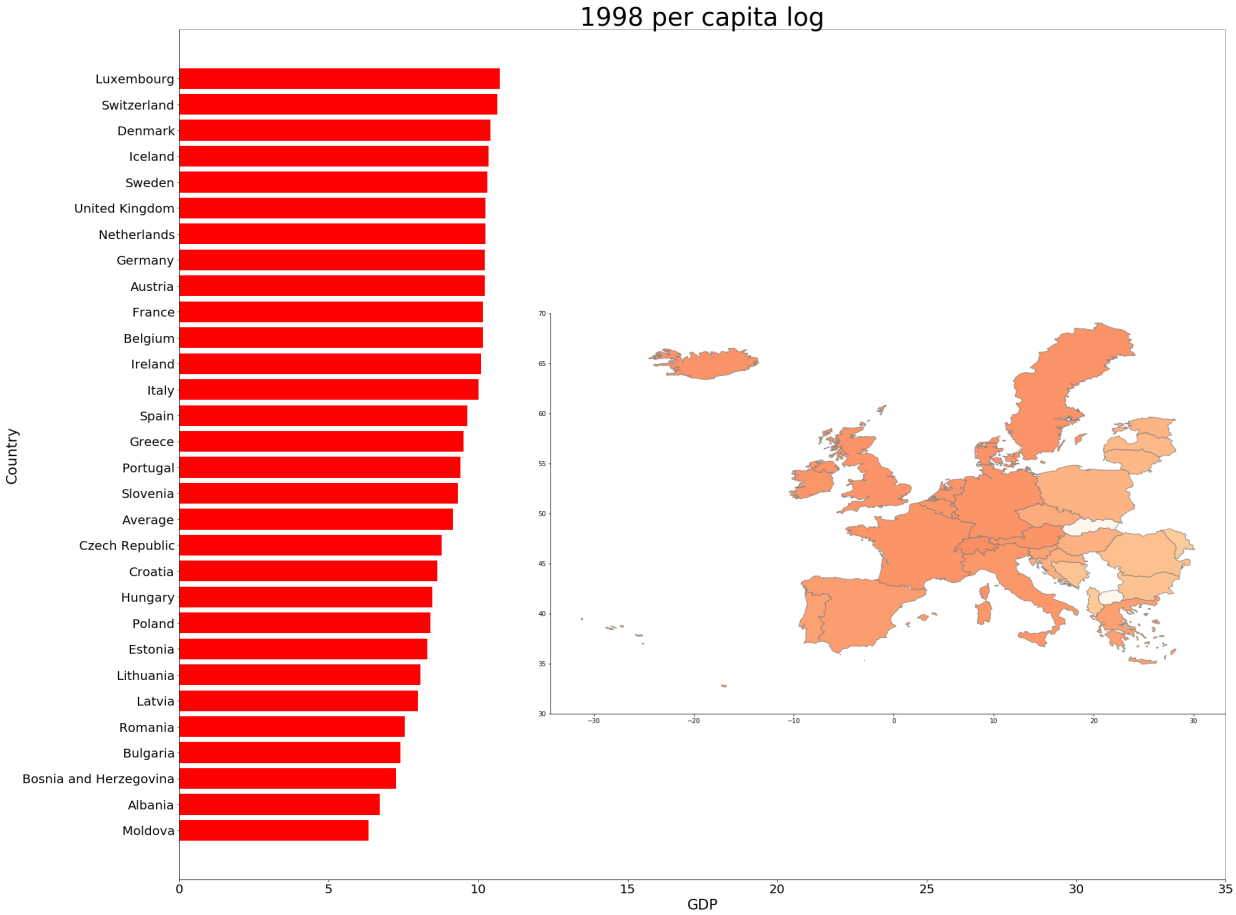
1998 per capita log
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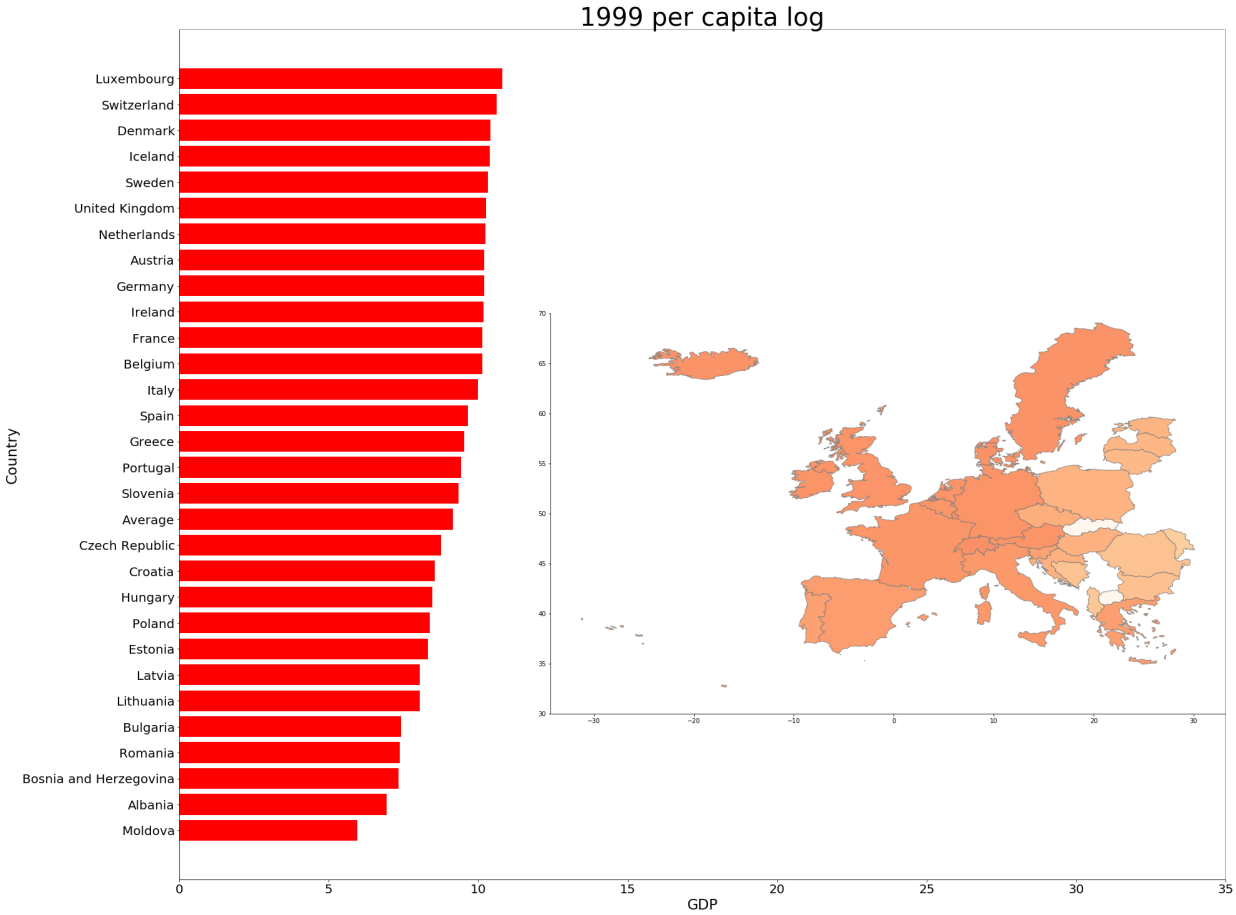
1999 per capita log
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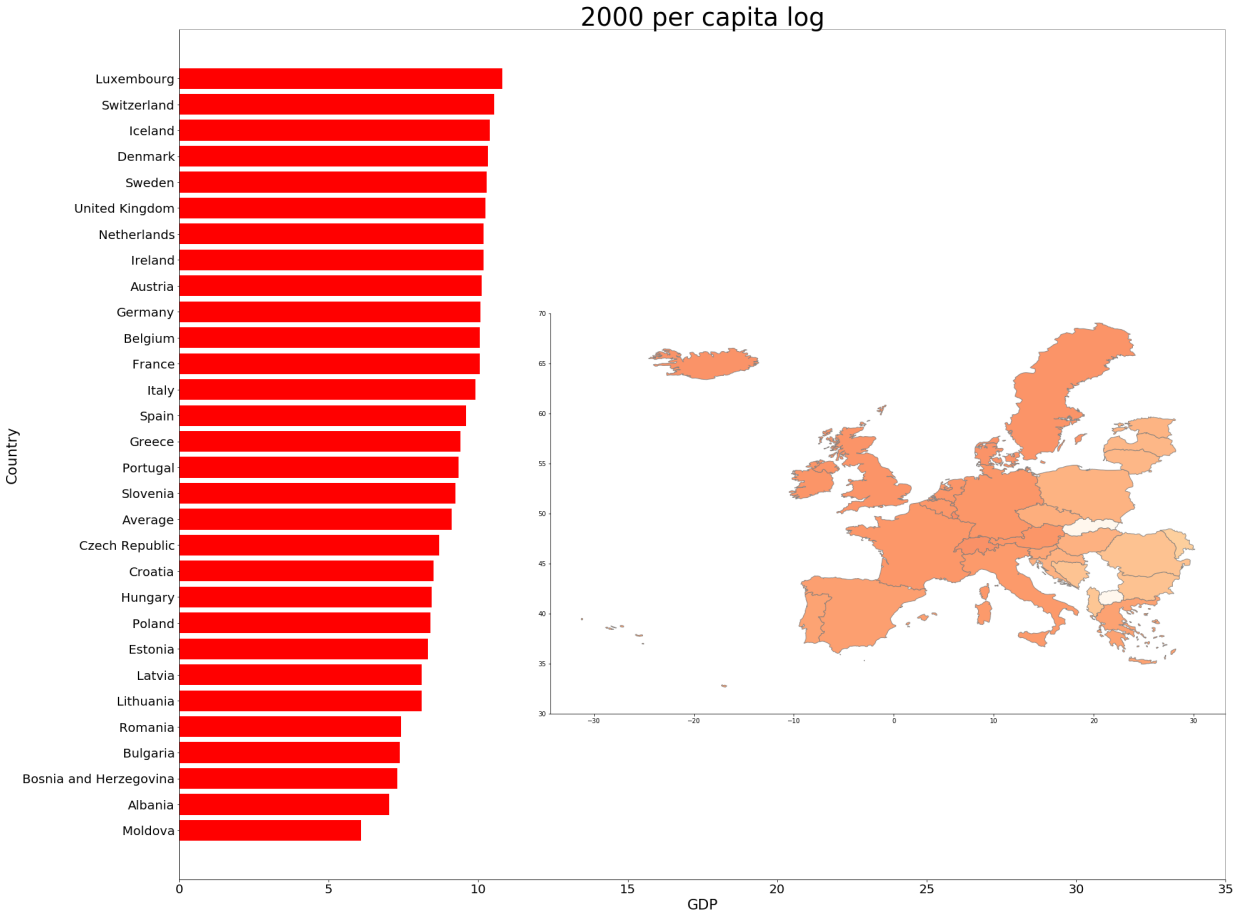
2000 per capita log
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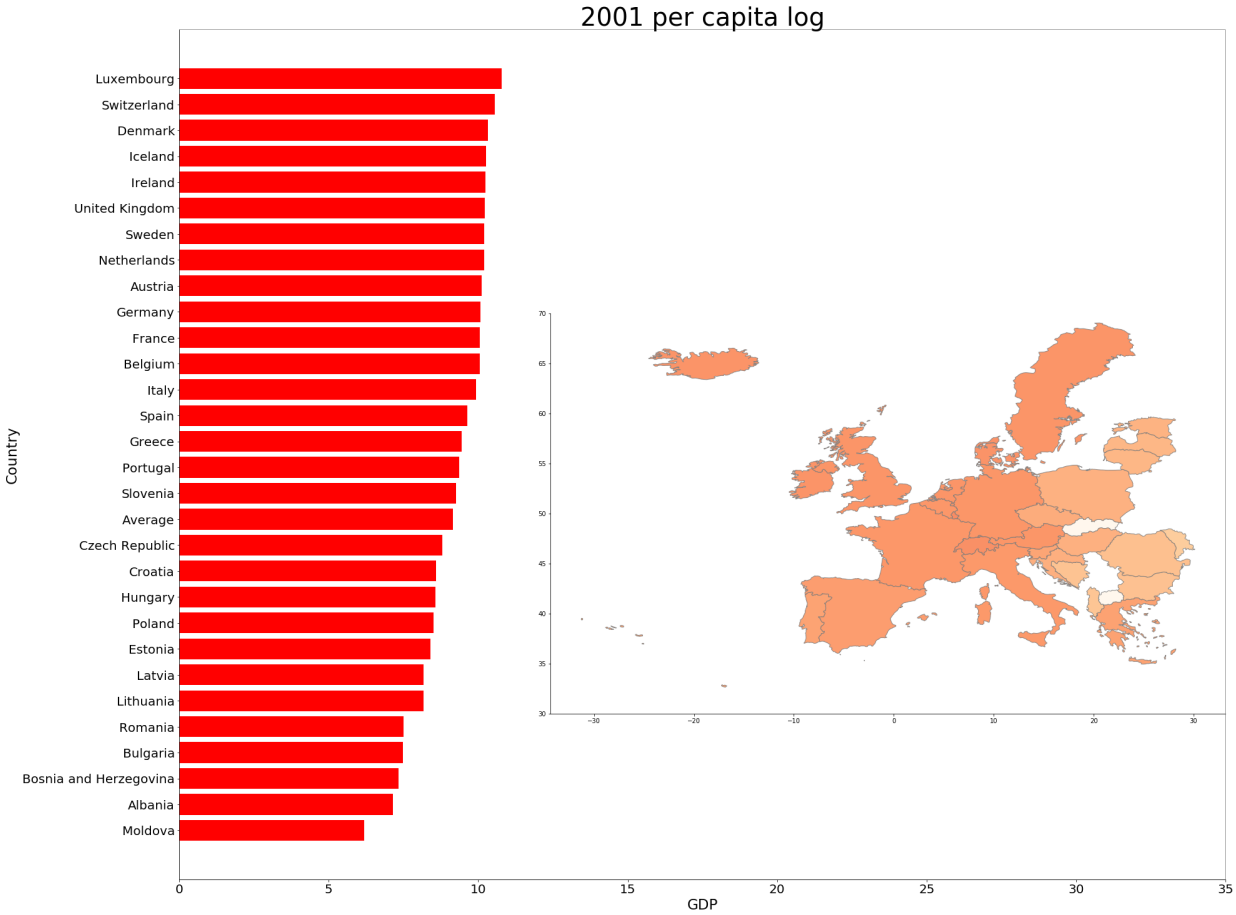
2001 per capita log
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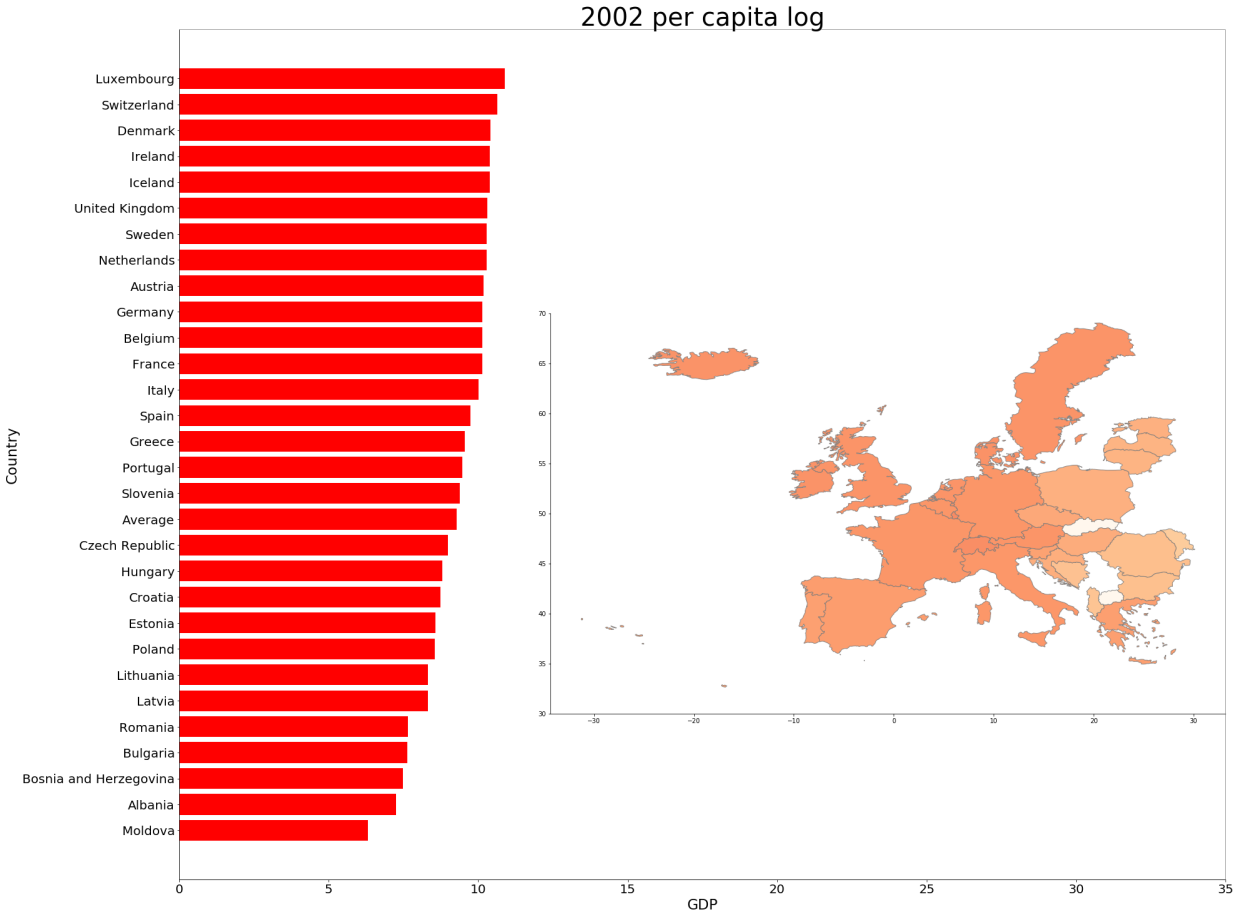
2002 per capita log
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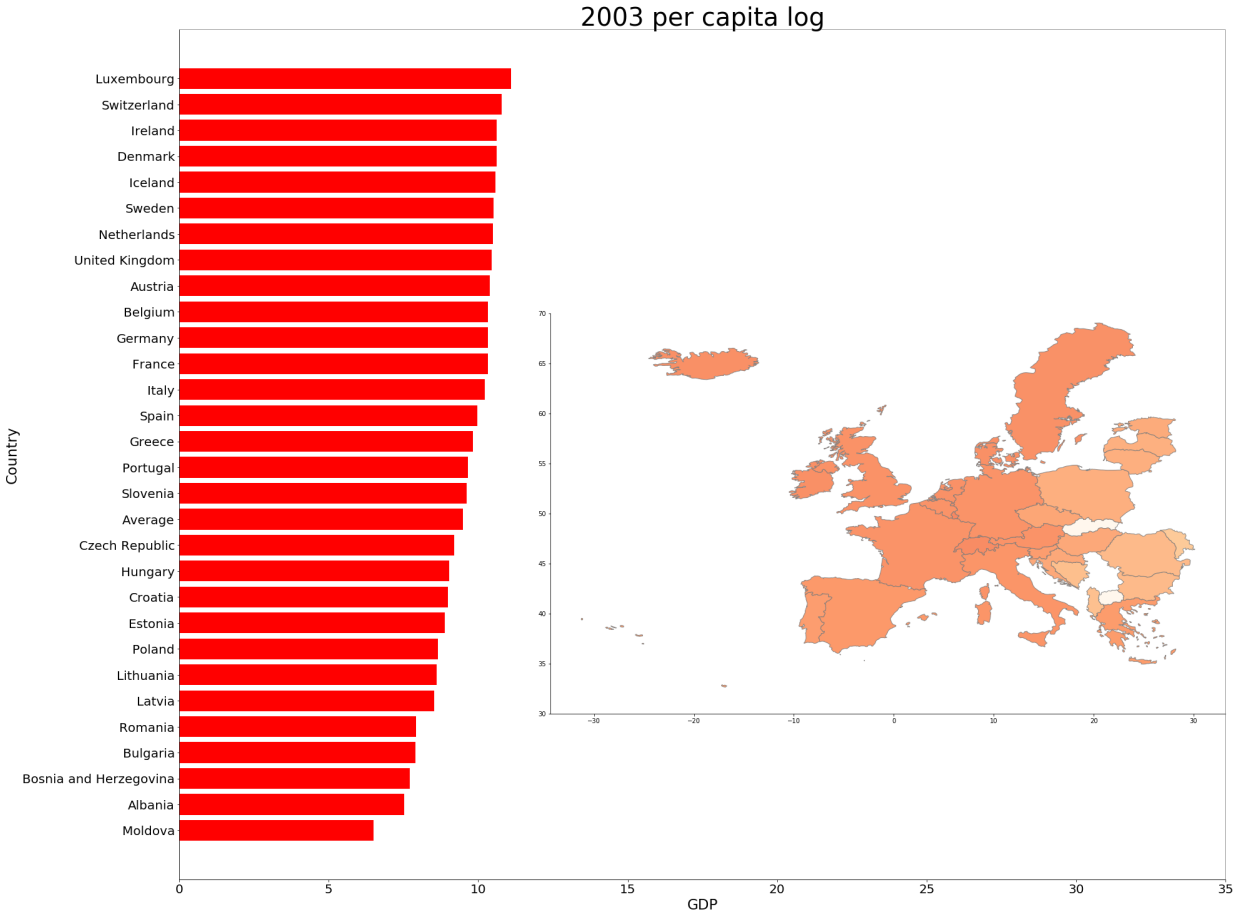
2003 per capita log
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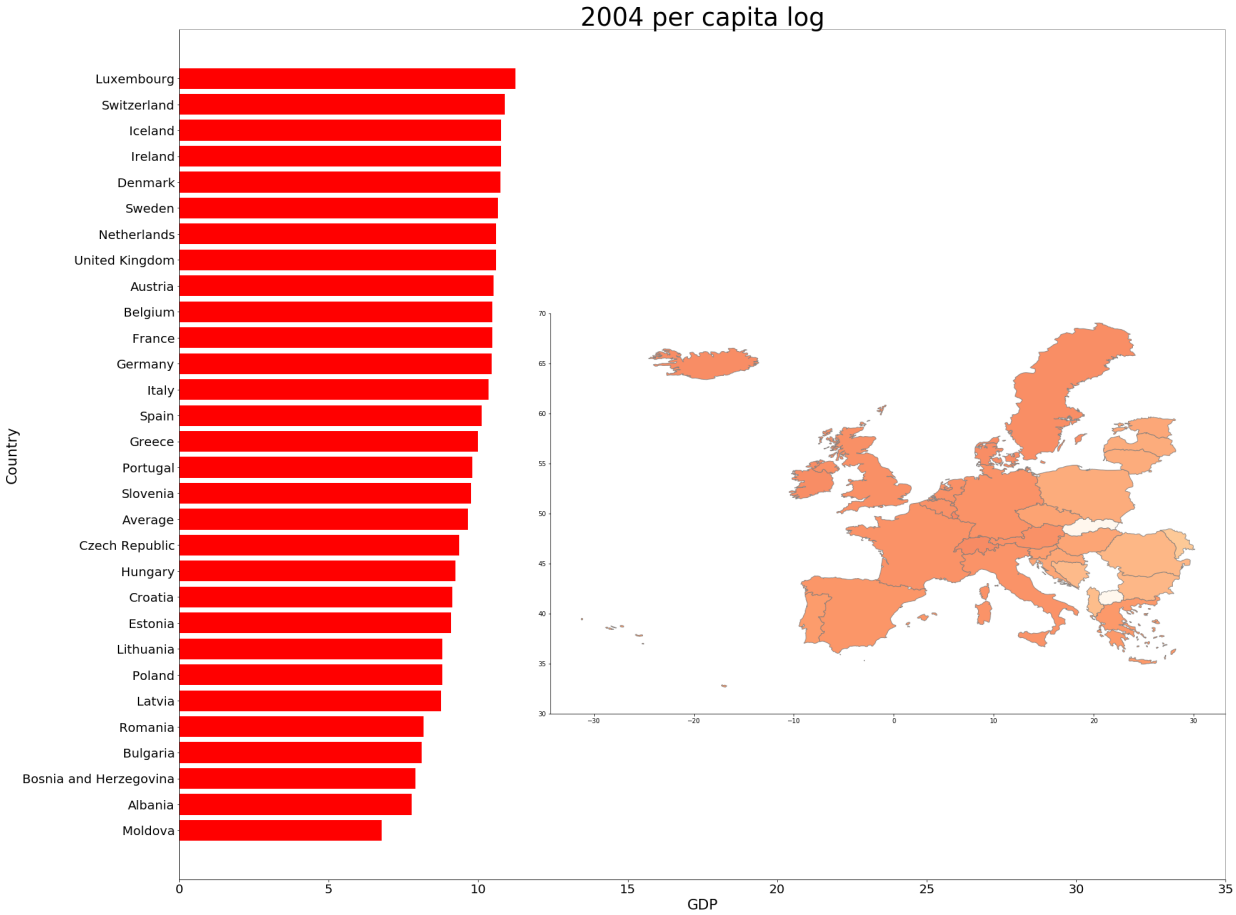
2004 per capita log
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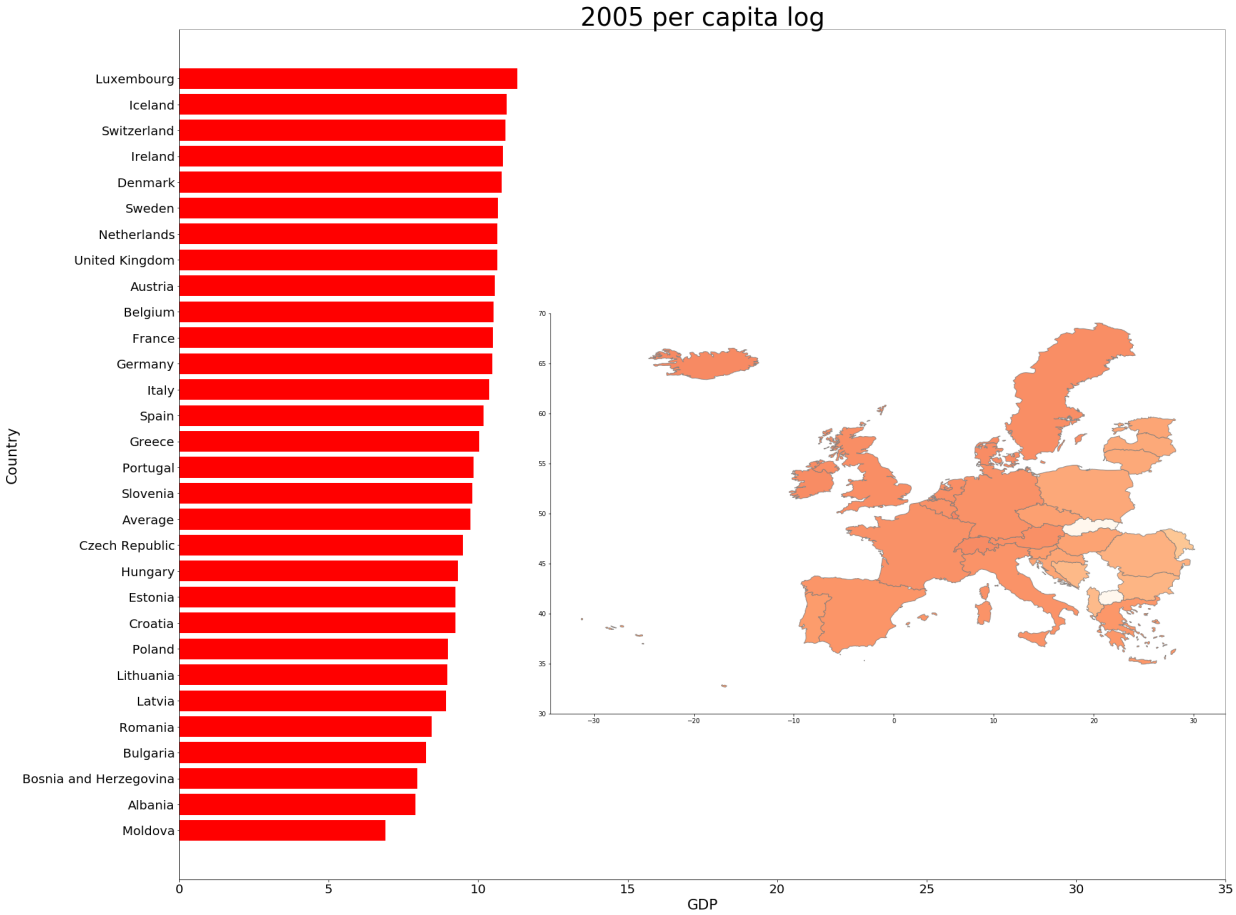
2005 per capita log
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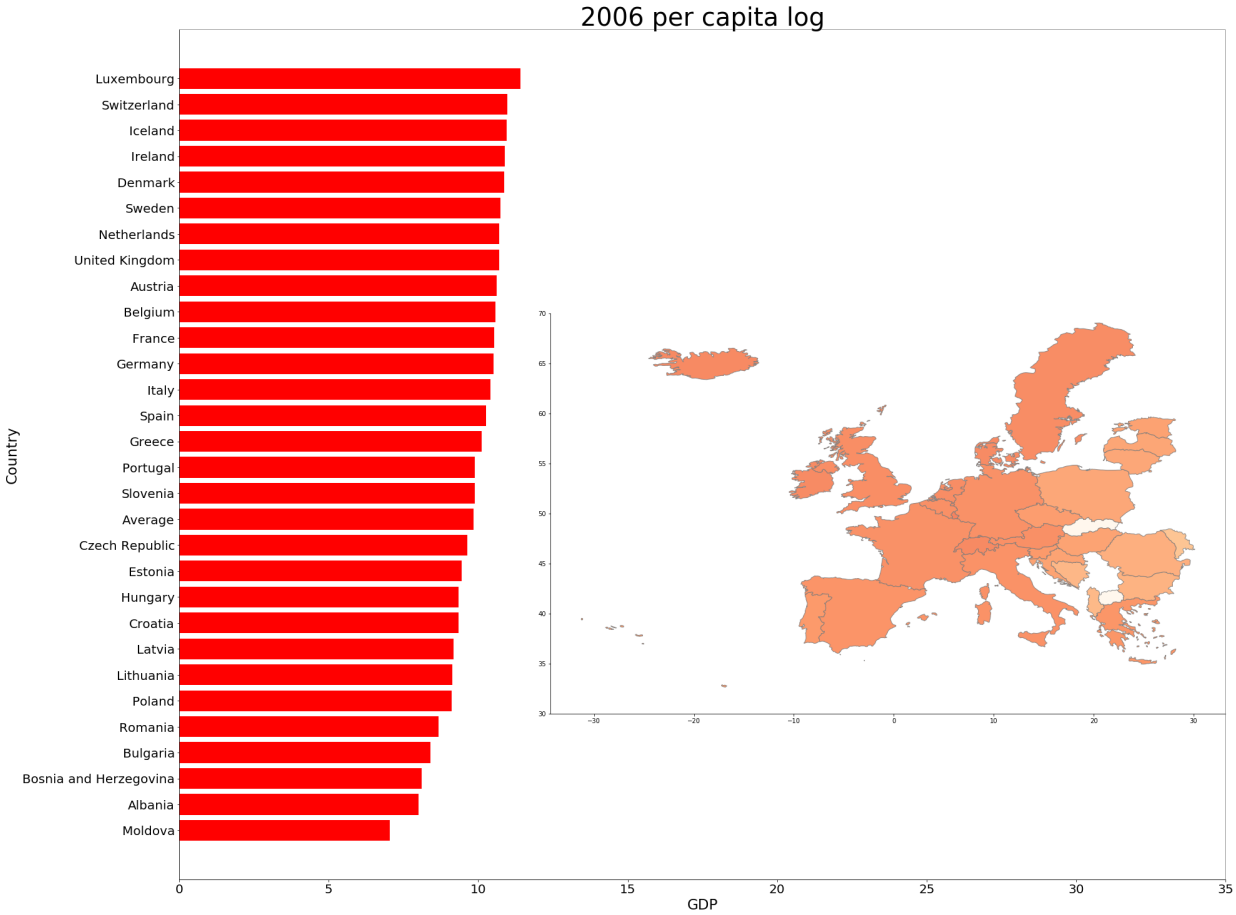
2006 per capita log
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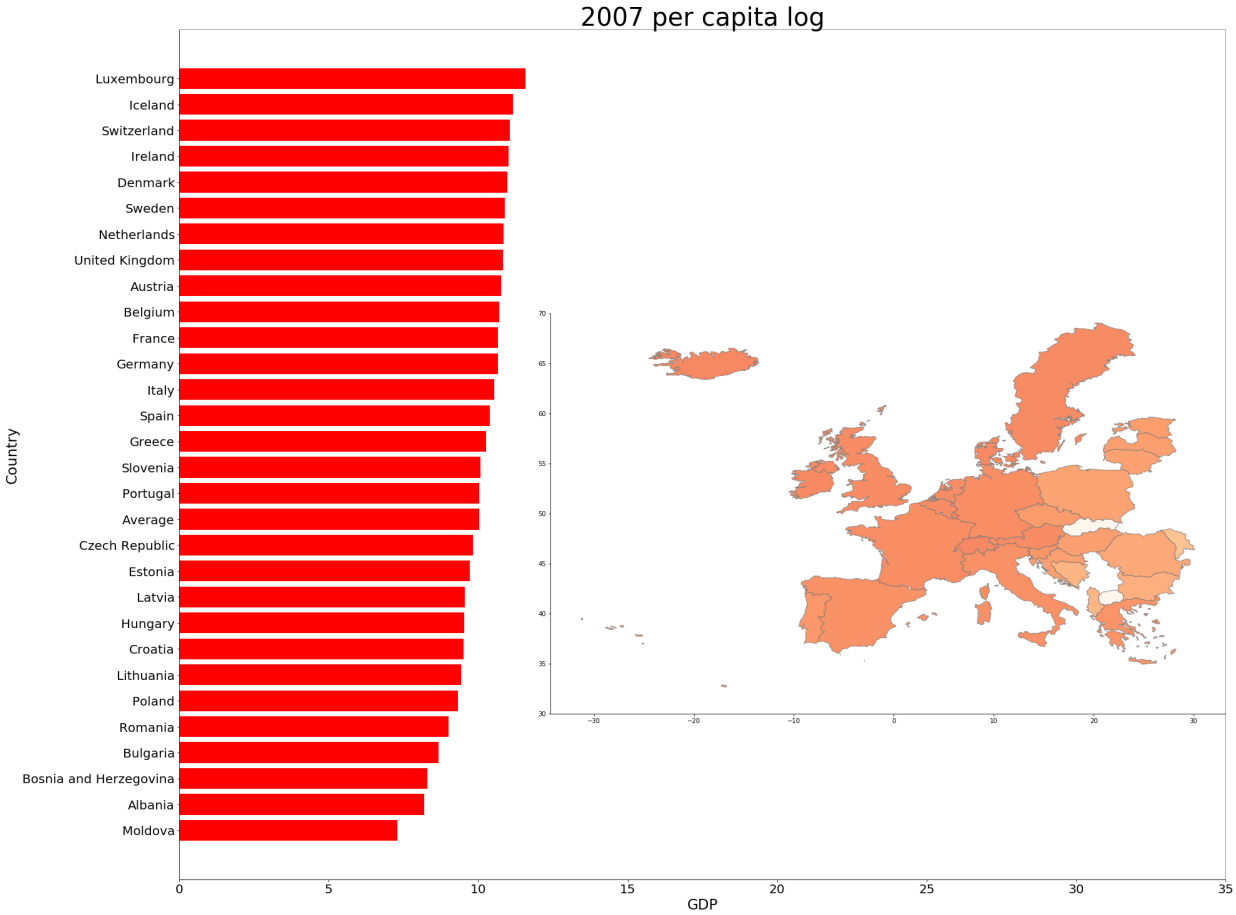
2007 per capita log
Luxembourg
Iceland
Switzerland
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Denmark
Sweden
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United Kingdom
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Greece
Slovenia
Portugal
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Czech Republic
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Latvia
Hungary
Croatia
Lithuania
Poland
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Bosnia and Herzegovina
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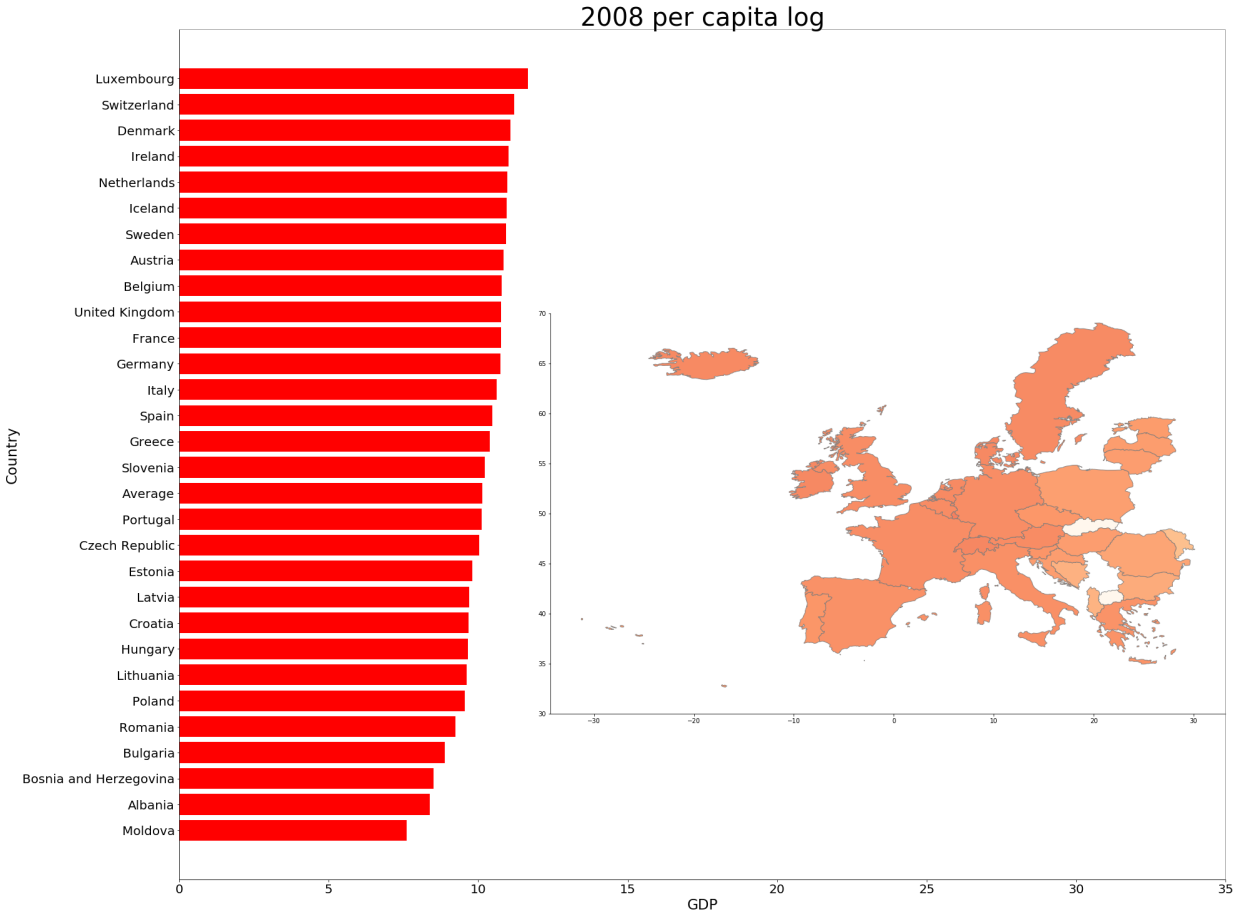
GDP


2008 per capita log
Luxembourg
Switzerland
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Italy
Spain
Greece
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Portugal
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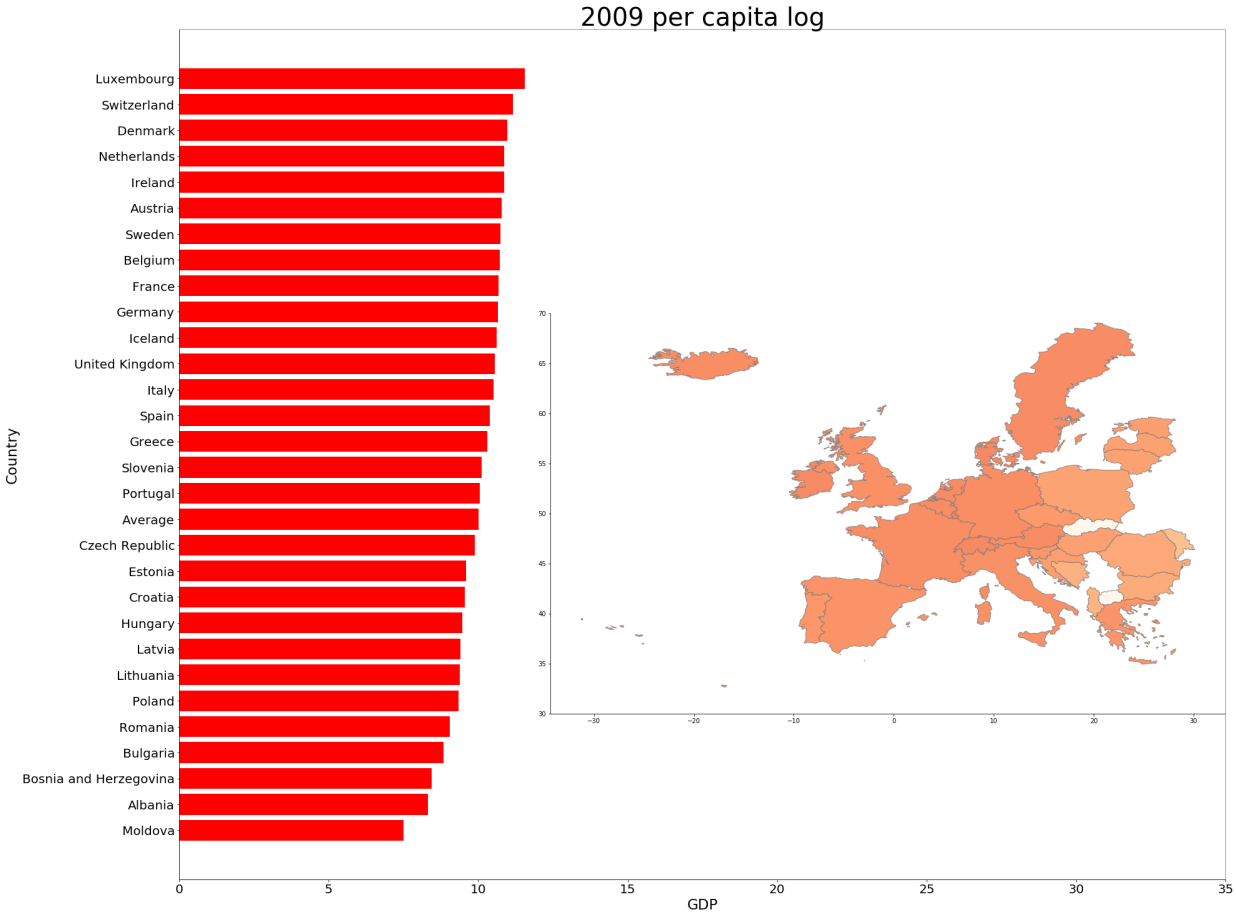
GDP


2009 per capita log
Luxembourg
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Greece
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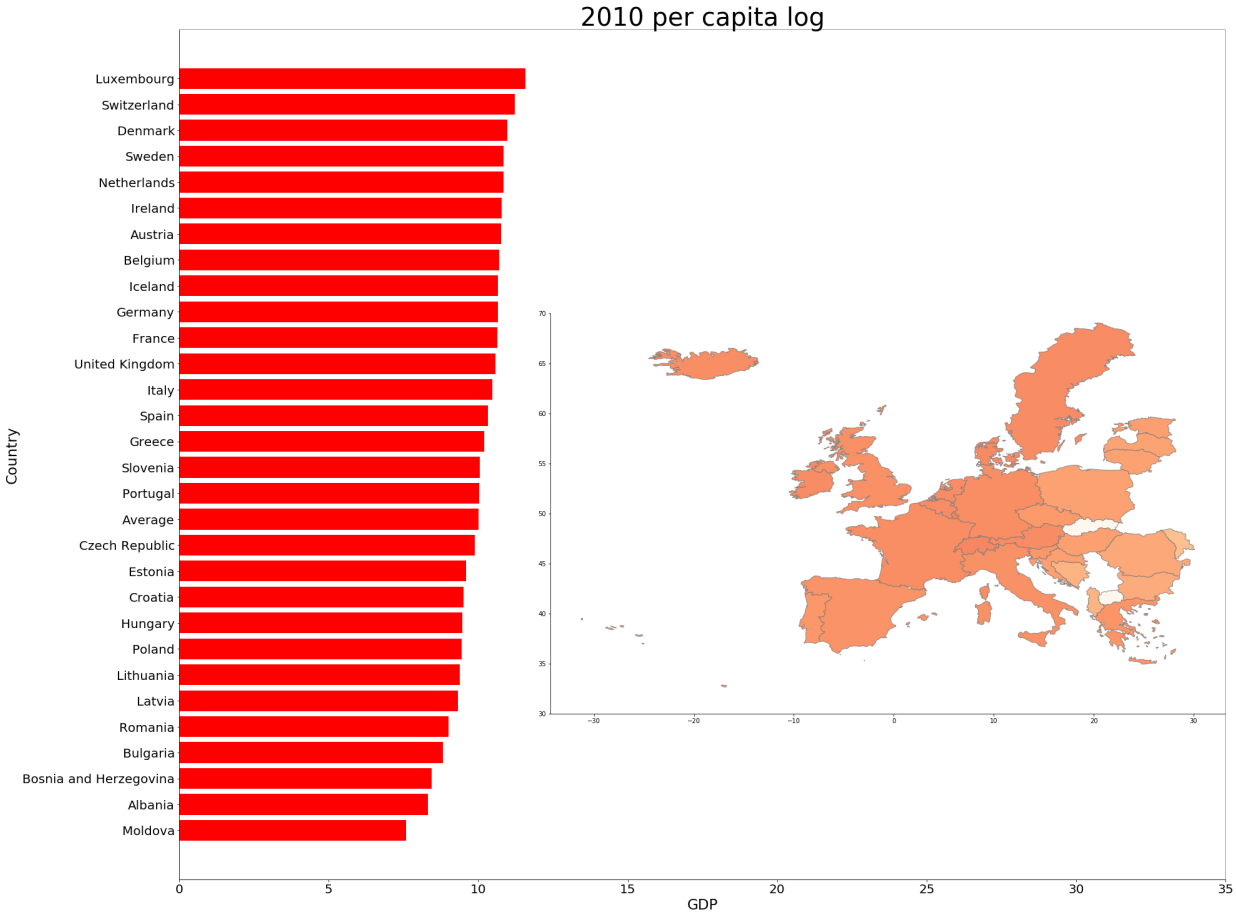
GDP


2010 per capita log
Luxembourg
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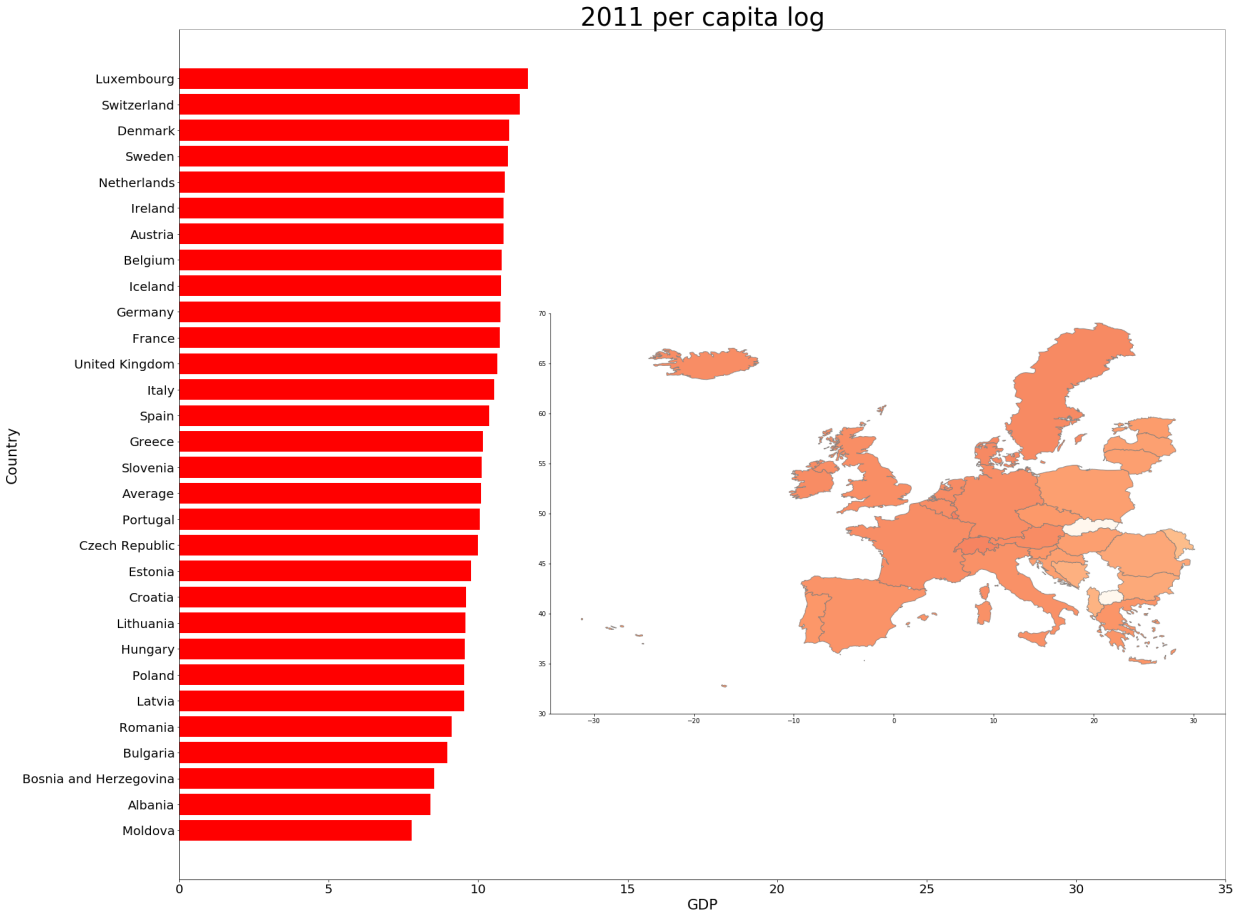
GDP


2011 per capita log
Luxembourg
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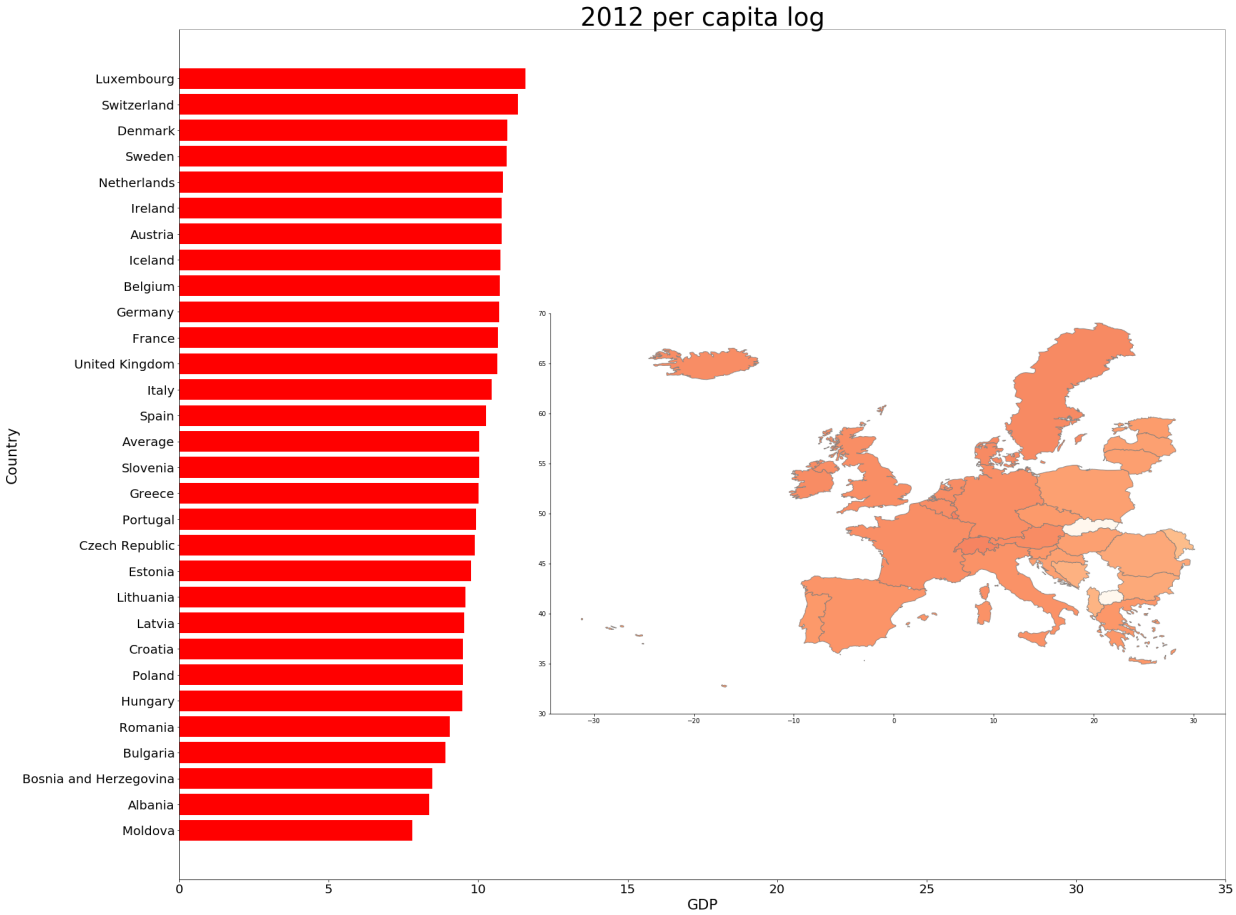
GDP


2012 per capita log
Luxembourg
Switzerland
Denmark
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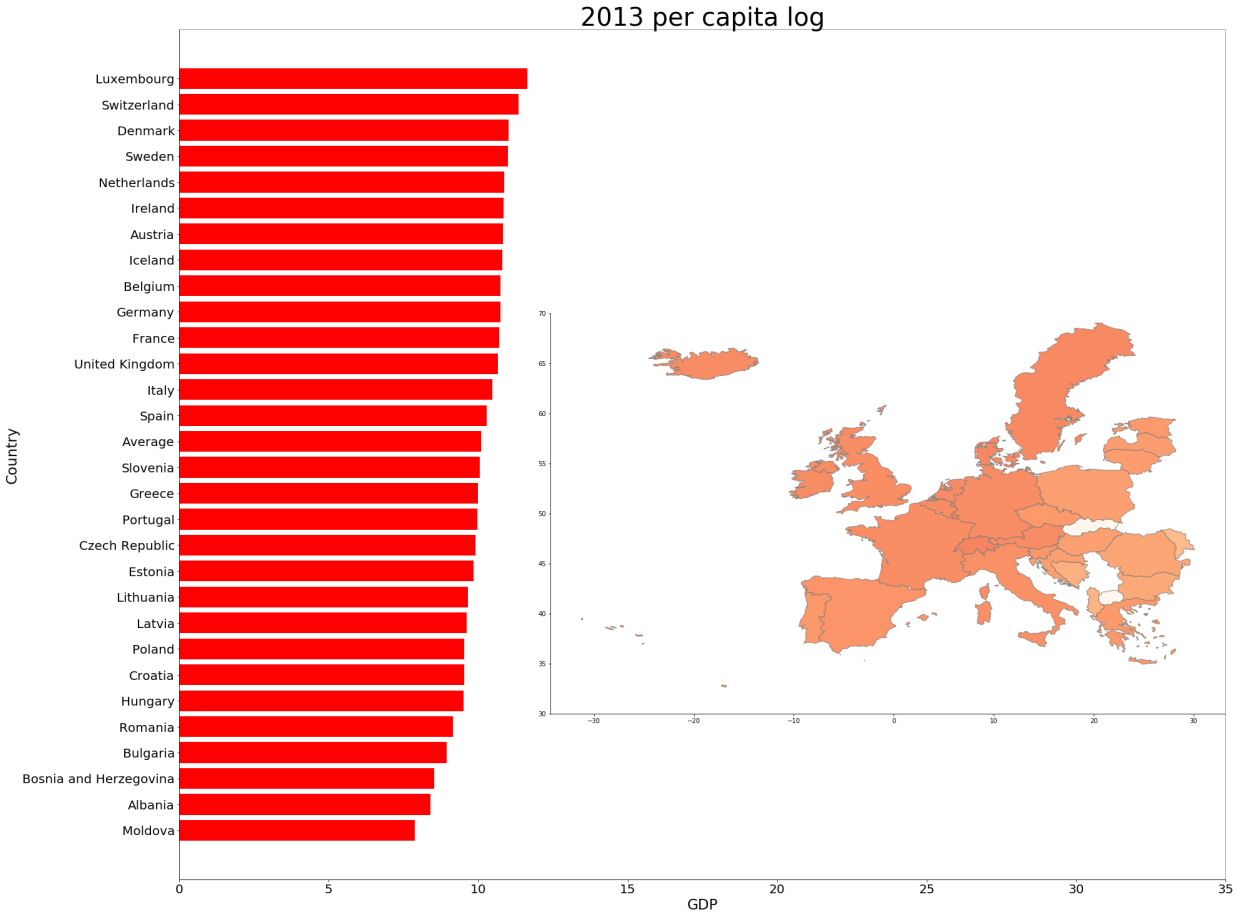
GDP


2013 per capita log
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United Kingdom
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Bulgaria
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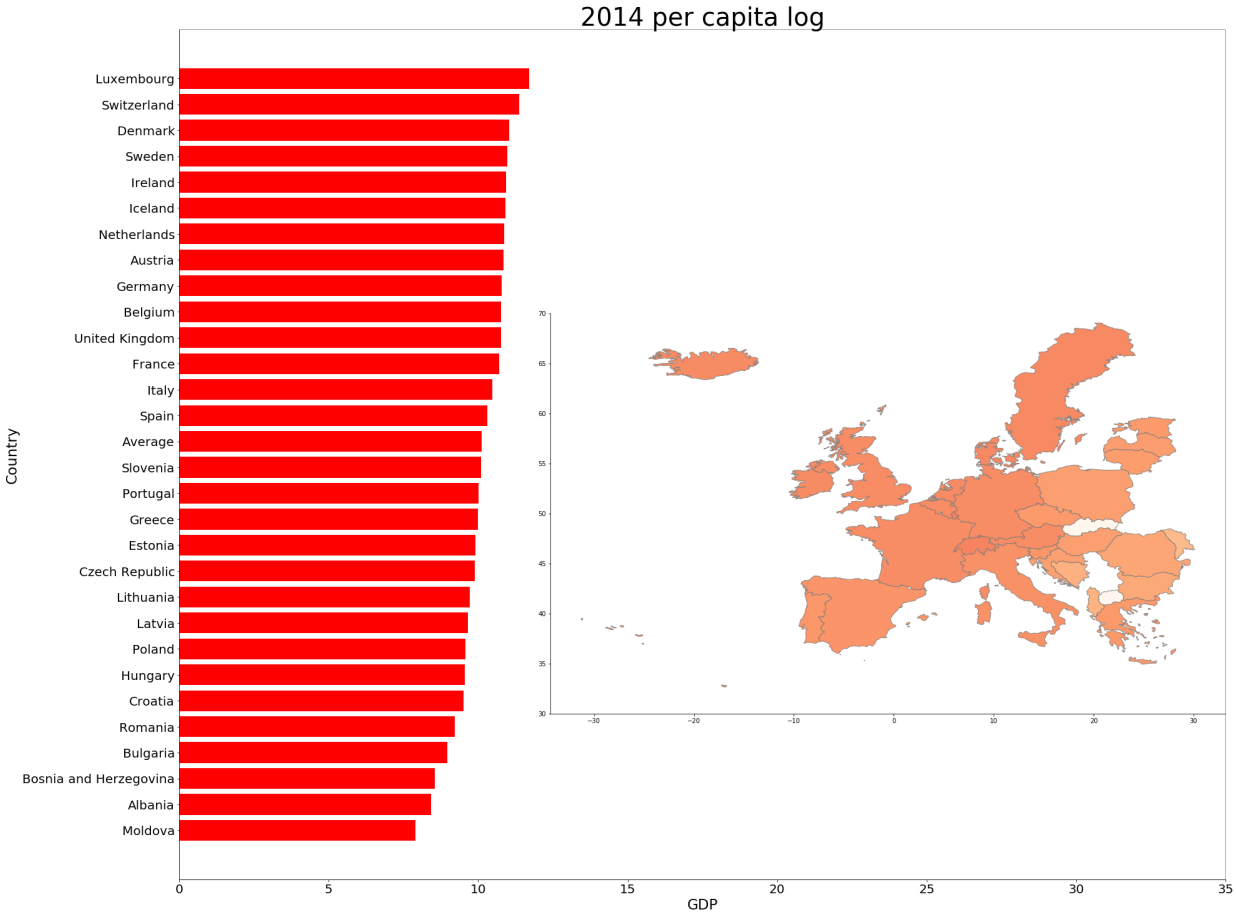
GDP


2014 per capita log
Luxembourg
Switzerland
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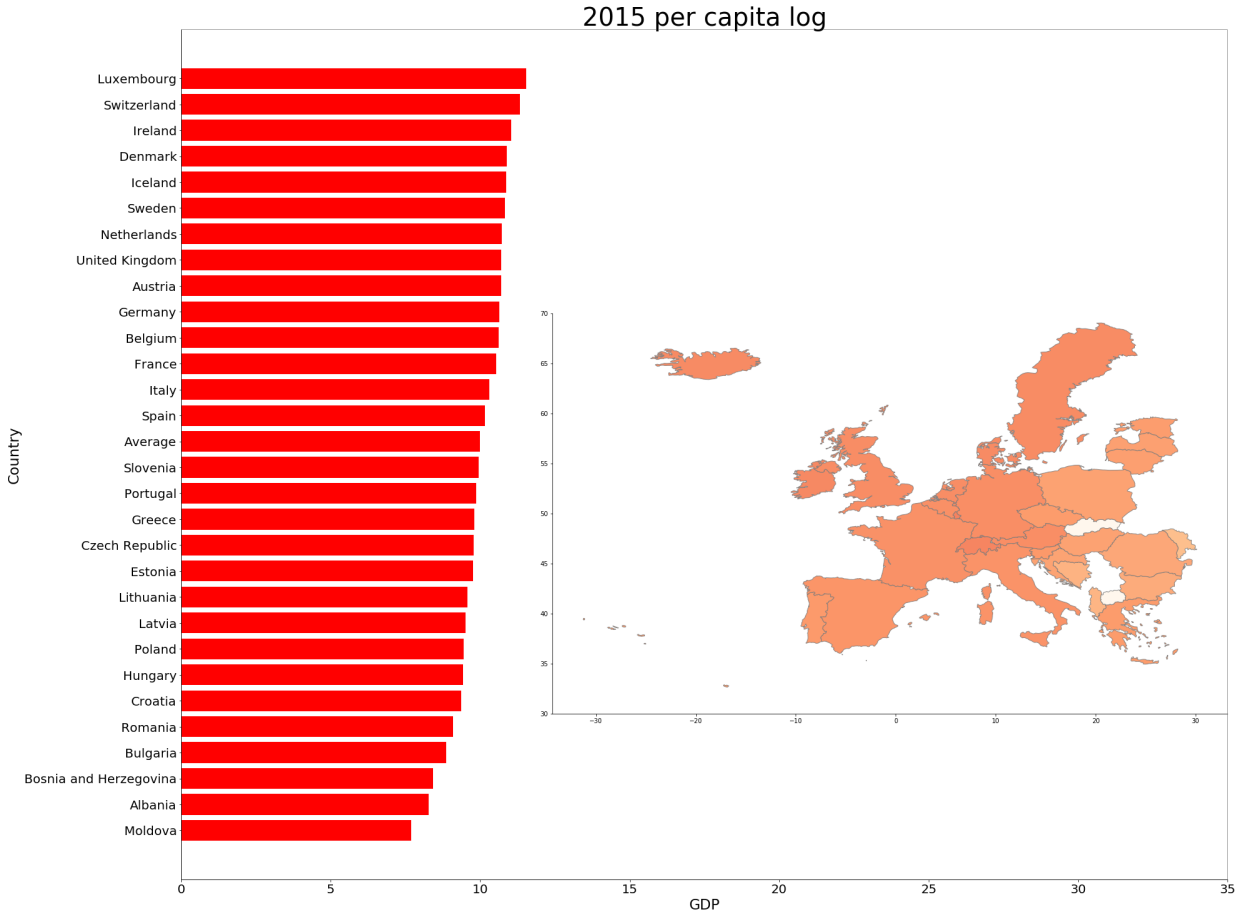

In [82]:
```
per_capita_log_pic_list = []

for year in year_per_capita_log_list:
    per_capita_log_pic_list.append(str(year)+".png")
```

In [83]:
```
pclimages = []
```

In [84]:
```
for filename in per_capita_log_pic_list:
    pclimages.append(imageio.imread(os.getcwd() + "/FinalOutput/" + fi
lename))
    imageio.mimsave(finaloutputpercapitaloggif, pclimages, duration =
1)
```